CONTRACT DOCUMENTS FOR CONSTRUCTION OF

John F. Kubala WTP

West High Service Pump Station

Pump 4 & 5 Additions

Project No. WUTR19020

City of Arlington

Department of Water Utilities

ARLINGTON℠

THE AMERICAN DREAM CITY

Issued for Bid

00 01 07 ENGINEER SEALS

	Specification Sections Sealed
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Arcadis US, Inc. Texas Registered Engineering Firm F-533	

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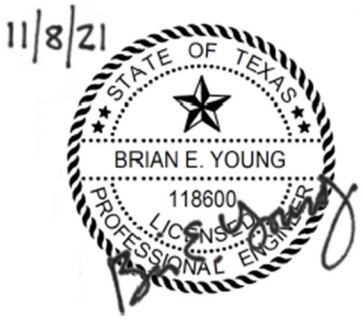	26 05 05 26 05 19 26 05 23 26 05 26 26 05 29 26 05 33.13 26 05 33.16 26 05 33.33 26 05 43.13 26 05 43.23 26 05 53 26 24 13 26 29 13.16 26 35 33 40 05 93
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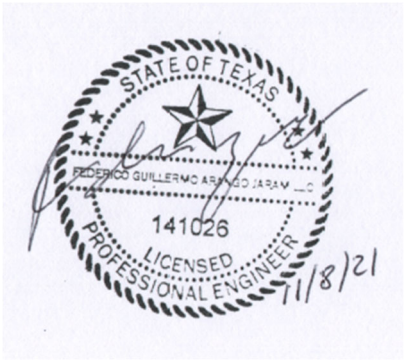	40 61 13 40 61 23 40 61 93 40 61 93A 40 61 96 40 70 05 40 70 05A
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INVITATION TO BID

Notice

The City of Arlington, Texas is requesting Bids for the construction of the following Project:

John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
Project Number WUTR19020

The Project includes the following Work

The Project Work consists of the purchase and installation of a two 5 MGD pumps and construction of a pump pad located east of the current West High Service Pump Station (WHSPS) to meet the current demands of the West Pressure Plane (WPP). The two pump additions will increase of the overall pump station capacity to 25 MGD and a firm capacity of 20 MGD.

The Engineer's Estimate for the Project is $2,613,000. The Project is to be complete and eligible for final payment 30 days after the date for Substantial Completion.

Obtaining Bidding Documents

Bidding Documents for the Project can be downloaded the following website:

https://arlington-tx.ionwave.net/Login.aspx

Prospective Bidders must register with this website as a plan holder, even if the Contract Documents are obtained from a plan room or other location. All official notifications, addenda, and other documents will be offered only through this website. Neither City of Arlington, Construction Manager nor Engineer will be responsible for Bidding Documents, including addenda, if any, obtained from sources other than this website.

Bidders are responsible for ensuring that a complete set of documents, as defined in Section 00 52 13 "Agreement," are used in the preparation of Bids. These documents are made available for the sole purpose of obtaining Bids and permission to download does not confer a license or grant permission or authorization for any other use. Authorization to download documents includes the right for Bidders to print documents for their use. Printed documents may not be re-sold under any circumstances.

Pre-Bid Conference

A non-mandatory virtual pre-bid conference for the Project will be held on Tuesday, November 30, 2021 at 10:00 AM.

Contractors intending to attend the virtual pre-bid conference should RSVP by Monday, November 29, 2021 by 2:00 PM to Ashley Brown at Ashley.Brown@arlingtontx.gov. If you have any questions concerning this project, please contact **Kevin Burks** at kevin.burks@arcadis.com.

Instructions to Bidders

Sealed Bids must be delivered to the Owner at the address below no later than 2:00 PM on Thursday December 16, 2021 to be accepted. Bids will be publicly opened, and the names of the Bidders and the amount of their Bids will be read aloud at this time and place. Bids received after this time will be returned unopened. Address Bids to the Owner as follows:

Office of the Director of Water Utilities
101 West Abram Street

Arlington, Texas 76010
2nd Floor of City Hall

See the Instructions to Bidders included in the Bidding Documents for detailed requirements for preparing and submitting a Bid and award of the Contract.

This Advertisement is issued by:

Owner: City of Arlington, Water Utilities Department By:
Ashley Brown
Title: Capital Projects Coordinator
First Advertisement Date: November 17, 2021
Second Advertisement Date: November 24, 2021

00 21 13 INSTRUCTIONS TO BIDDERS

ARTICLE 1 – DEFINED TERMS

1.01 The terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions.

ARTICLE 2 – RECEIPT OF BIDS

2.01 Complete and deliver the Bid Form along with all required documents identified in the Bid Form. Sealed Bids must be delivered to the Owner at the time and location stipulated in the Invitation to Bid.

2.02 Enclose the Bid along with the Bid Bond and other required documents in an opaque sealed envelope plainly marked with the Project name, as shown on the front cover of the Contract Documents, and the name and address of the Bidder. Envelope is to be clearly marked with the words “BID DOCUMENTS” OR “BID PROPOSAL”

ARTICLE 3 – COPIES OF CONTRACT DOCUMENTS

3.01 Obtain a complete set of the Contract Documents as indicated in Section 00 52 13 “Agreement.”

3.02 Use complete sets of Contract Documents in preparing Bids. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete sets of Contract Documents.

3.03 Owner makes copies of Contract Documents available for the sole purpose of obtaining Bids for completion of the Project and does not confer a license or grant permission or authorization for any other use.

ARTICLE 4 – QUALIFICATIONS STATEMENT

4.01 Submit information as required in Section 00 45 13 “Qualifications Statement” with the Bid.

ARTICLE 5 – EXAMINATION OF THE CONTRACT DOCUMENTS AND THE SITE

5.01 Examine the Contract Documents, the Site, and other information readily available before submitting a Bid.

A. Carefully study the Contract Documents.

B. Carefully study supplemental information, including Technical Data, record drawings from previous projects, available utility maps, reports, and studies referenced or made available to the Bidder.

C. Visit the Site to become familiar with any general, local, or Site conditions that may affect the cost, progress, or performance of the Work in any manner.

D. Become familiar with all federal, state, and local Laws and Regulations that may affect cost, progress, or the completion of Work.

E. Make observations and investigations, correlate knowledge and observations with the requirements of the Contract Documents and consider these in preparation of a Bid for the Project.

F. Determine that the Contract Documents, Addenda, and supplemental data are generally adequate to indicate and convey understanding of all terms and conditions for completion of Work to the degree necessary to prepare a Bid for the Project.

G. Promptly notify the Construction Manager of all conflicts, errors, ambiguities, or discrepancies that the Bidder discovers in the Contract Documents, Addenda, and supplemental information.

5.02 The submission of a Bid will constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Article, that without exception, the Bid is premised upon completion of Work required by the Contract Documents, that the Bidder has given the OPT written notice of all conflicts, errors, ambiguities, and discrepancies that the Bidder has discovered in the Contract Documents, and that the Contract Documents adequately indicate and convey understanding of all terms and conditions required for preparation of the Bid and completion of Work.

ARTICLE 6 – PRE-BID CONFERENCE AND SITE VISIT

6.01 A non-mandatory pre-bid conference will be held at the time and location indicated in Section 00 11 16 “Invitation to Bid.”

6.02 See the Invitation for Bids for details on attending the pre-proposal conference and site tour.

ARTICLE 7 – QUESTIONS AND INTERPRETATIONS

7.01 Submit all questions about the meaning or intent of the Contract Documents, Addenda, and the related supplemental data to kevin.burks@arcadis.com. All inquiries must be received no later than ten calendar days prior to opening of bids. The City cannot guarantee a response if the inquiry or request is not submitted in time. Any interpretation of these documents will be made by addendum duly issued. The Owner will not be responsible for any other explanations or interpretations.

ARTICLE 8 – PROPOSED ALTERNATES

8.01 Submit requests for alternate terms and conditions, approval of Work not in strict compliance with the Contract Documents, or requests to include products of Manufacturer’s not listed as approved Manufacturers in a specification to the OPT no later than 10 days after the date the Project is first advertised. Provide all the information required for a substitution per Section 01042 “Change Management”. OPT will consider the request and issue an Addenda as appropriate if the proposed changes to the Contract Documents are accepted. A Proposal submitted with clarifications or taking exceptions to the Contract Documents, except as modified by Addenda, will be considered non-responsive.

ARTICLE 9 – BID BOND

9.01 Bidders must submit an acceptable bid bond as a guarantee that, if awarded the contract, the Bidder will enter into a contract with the Owner and provide all required bonds and evidence of

insurance within the times stipulated in the Contract Documents. Bid Bond must be in the amount of 5 % of the base Bid amount plus allowances, extra work items, and alternates. The bond must be issued by a surety legally authorized to do business in Texas and meet the requirements of the General Conditions to be acceptable. Bidder and Surety bind themselves to pay the Owner the amount of the Bid Bond upon Bidder's failure to enter into a contract with the Owner and provide all required bonds and evidence of insurance within the times stipulated in the Contract Documents.

9.02 Bid Securities are to remain in effect until the Contract is executed. Bid bonds will become void when the Contract is awarded, or all Bids are rejected.

ARTICLE 10 – CONTRACT TIMES

10.01 See applicable provisions for Contract Times in the Agreement.

ARTICLE 11 – PREPARATION OF THE BID FORM

11.01 The Bid Form is included with the Contract Documents. Complete all blanks on the Bid Form by typing or printing in ink. Indicate prices for each item or alternate shown in the Bid Form.

11.02 The unit price governs if a conflict exists between the extended amount derived by multiplying the unit price by the stated quantity of units and the extended amount shown in the Bid Form.

11.03 Execute the Bid Form as indicated in the document and include evidence of authority to sign.

11.04 Acknowledge receipt of all Addenda by filling in the number and date of each Addendum. Provide a signature as indicated to verify that the Addenda were received. A Bid that does not acknowledge the receipt of all Addenda may be considered non-responsive.

11.05 Provide the name, address, and telephone number of the individual to be contacted for any communications regarding the Bid in the Bid Form.

11.06 Provide evidence of the Bidder's authority and qualification to do business in Texas or agree to obtain such qualification prior to award of the Contract. Failure to obtain this qualification will render the Bid non-responsive and Bidder will forfeit its Bid Security.

ARTICLE 12 – CONFIDENTIALITY OF BID INFORMATION

12.01 In accordance with Texas Government Code §552.110, trade secrets and confidential information in Bids are not open for public inspection. Bids will be opened in a manner that avoids disclosure of confidential information to competing Bidders and keeps the Bids from the public until a contract is awarded. All Bids are open for public inspection after the Contract is awarded, however trade secrets and confidential information in Bids may not be open for public inspection. The Owner will protect this information to the extent allowed by law.

12.02 Clearly indicate which specific documents are considered to be trade secrets or confidential information by stamping or watermarking all such documents with the word "confidential" prominently on each page or sheet or on the cover of bound documents. Place "confidential" stamps or watermarks so that they do not obscure any of the required information on the document, either in the original or in a way that would obscure any of the required information in a photocopy of the document. Submit all confidential information in a different binder so this confidential material is separate for the rest of the Bid.

12.03 Owner is a governmental body subject to the limitation of Texas Government Code Chapter 552 and has limited obligations with regard to protecting confidential information submitted by Bidders. Owner, upon receiving an application or other request for the disclosure of confidential information, will promptly notify the Bidder of the request as required by Texas Government Code §552.305 and request a ruling by the Texas Attorney General as to whether any such information may be released.

12.04 Bidder acknowledges and agrees that it will be solely responsible for submitting any arguments, authorities, or other information to the Attorney General of Texas regarding release of the information marked as confidential as provided by Texas Government Code §552.305(b) and that if disclosure is required, the Owner has no liability for releasing this information and the Bidder will not be entitled to exercise any remedy for a disclosure made pursuant to the Texas Government Code Chapter 552.

12.05 The obligations of the Owner as recipient with respect to confidential information under the terms of this Agreement are subject to the following exceptions:

A. If confidential information becomes a part of the public domain through publication or otherwise but through no fault of the Owner;

B. Owner can demonstrate through suitable documentation that the confidential information was already in the Owner's possession or otherwise publicly available prior to the date of disclosure hereunder;

C. The confidential information is subsequently disclosed to the Owner by a third party who has a lawful right to disclose such information; or

D. The Owner is required to disclose the confidential information by court order or by applicable law.

12.06 If the Owner is requested or becomes legally compelled (by oral questions, interrogatories, requests for information or documents, subpoena, civil or criminal investigative demand, public information requests, including requests under Texas Government Code Chapter 552, or similar process) or is required by a regulatory body to make any disclosure that is prohibited or otherwise constrained by this Agreement, the Owner will provide the Bidder with prompt notice of this request so that it may seek an appropriate protective order or other appropriate remedy.

12.07 Notwithstanding any other provision of the Contract Documents, it is stipulated and agreed that by accepting a Bid, the Owner has not and does not waive its sovereign immunity from suit and/or liability.

ARTICLE 13 – DELIVERY OF BIDS

13.01 Complete and deliver the Bid Form along with all required documents identified in the Bid Form.

13.02 Provide both a printed copy of Bid documents and an electronic copy of these documents on a flash drive.

13.03 Submit the Bid no later than the date and time prescribed and at the place indicated in the Invitation to Bid. Enclose the Bid in an opaque sealed envelope plainly marked with the Project name and the name and address of the Bidder, along with the Bid Bond and other required documents. Address the envelope to the mailing address shown in Section 00 11 16 "Invitation to Bid." Bidder assumes full responsibility for ensuring that the Bid arrives at the prescribed location before the prescribed time.

ARTICLE 14 – MODIFICATION OR WITHDRAWAL OF BIDS

14.01 Modify or withdraw a Bid using a document executed in the same manner that a Bid must be executed. Deliver the document to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

14.02 A Bidder may withdraw its Bid within 24 hours after Bids are opened if the Bidder files a signed written notice with the Owner and promptly thereafter demonstrates to the reasonable satisfaction of the Owner that there was a material and substantial mistake in the preparation of its Bid. The Bid Bond will be returned if it is clearly demonstrated to the Owner that there was a material and substantial mistake in its Bid. A Bidder that requests to withdraw its Bid under these conditions may be disqualified from responding to a reissued Invitation to Bid for the Work to be furnished under these Contract Documents.

ARTICLE 15 – OPENING OF BIDS

15.01 Bids will be opened at the time and place indicated in Section 00 11 16 "Invitation to Bid." The Owner will publicly acknowledge receipt of Bids received in time to be considered and then open and read aloud the names of the Bidders and the amount bid as required by applicable Laws and Regulations.

ARTICLE 16 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

16.01 No bid may be withdrawn until the expiration of ninety (90) days from the date bids are opened. Owner may, at its sole discretion, release any Bid and return the Bid Bond prior to the end of this period.

ARTICLE 17 – EVALUATION OF BIDS

17.01 Owner will consider the proposed Contract Price and Contract Times and the qualifications of the Bidders to determine the lowest responsible Bidder.

17.02 Owner may conduct such investigations as it deems necessary to establish the responsibility, qualifications, and financial ability of consultants, individuals, or entities proposed to furnish parts of the Work in accordance with the Contract Documents.

17.03 Each Bidder agrees to waive any claim it has or may have against the members of the OPT and their respective employees, arising out of or in connection with the administration, evaluation, or recommendation of any Bid.

ARTICLE 18 – AWARD OF CONTRACT

18.01 Owner reserves the right to reject any and all Bids, including non-conforming, non-responsive, or conditional Bids. Owner may also reject the Bid of any Bidder if the Owner believes that it would not be in the best interest of the Owner to make an award to that Bidder. Owner reserves the right to waive all formalities.

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

18.03 The Contract will be awarded to the lowest responsible Bidder if a contract is to be awarded.

18.04 Owner may consider the following in evaluating the Bids and awarding the Contract:

A. Bidder's qualifications and ability to demonstrate current capability to complete the Project in conformance with the requirements of the Contract Documents.

B. Compliance of the Bids with requirements of the Contract Documents.

C. Alternates and unit prices if requested in the bid forms.

D. The amount bid.

E. Proposed date of completion and the ability to meet intermediate Milestones that may have been established for the Project.

ARTICLE 19 – BONDS AND INSURANCE

19.01 The General Conditions set forth the Owner's requirements as to bonds and insurance. When the Successful Bidder delivers the executed Agreement to the Owner, it must be accompanied by the performance and payment bonds and required evidence of insurance.

19.02 The performance and payment bonds provided for this Project must fully comply with the provisions of Texas Government Code Chapter 2253. Administration of these bonds will conform to Texas Government Code Chapter 2253 and the provisions of the Contract Documents.

ARTICLE 20 – SIGNING OF THE AGREEMENT

20.01 The Notice of Award to the Successful Bidder will be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents that are identified in the Agreement. The Successful Bidder must sign and deliver the required number of counterparts of the Agreement and attached documents to the Owner within 15 days. Owner will deliver two fully signed counterparts to the Successful Bidder within 10 days after receiving the signed documents from the Successful Bidder.

20.02 The Successful Bidder must also complete and submit a Certificate of Interested Parties (Form 1295) to the Owner as required by Texas Government Code Chapter 2252 with the signed Agreement.

ARTICLE 21 – SALES AND USE TAXES

21.01 The Owner generally qualifies as a tax exempt agency as defined by the statutes of the State of Texas and is usually not subject to any city or state sales or use taxes, however certain items such as rented equipment may be taxable even though Owner is a tax-exempt agency. Assume responsibility for including any applicable sales taxes in the Contract Price and assume responsibility for complying with all applicable statutes and rulings of the State of Texas Comptroller.

21.02 It is the Owner's intent to have this Contract qualify as a "separated contract." Complete the following requirements for this contract to qualify:

A. Obtain a sales tax permit from the State of Texas Comptroller if awarded this Contract.

B. Identify the dollar value of materials exempt from the sales tax. This information must be reported in Section 00 45 04 “Compliance to State Sales Tax Code.”

ARTICLE 22 – WAGE RATES

22.01 This Contract is subject to Texas Government Code Chapter 2258 concerning payment of prevailing wage rates. Requirements for paying the prevailing wage rates are discussed in Section 00 73 43 “Wage Rate Requirements.” A schedule listing the minimum wage rates for various classifications of laborers which have been established by the Owner for this Project are included in Section 00 73 46 “Wage Determination Schedule.” Bidders must pay not less than the minimum wage shown on this list and comply with all statutes and ruling of the State of Texas Comptroller.

ARTICLE 23 – REQUIRED AFFIDAVITS AND CERTIFICATIONS

23.01 Apparent low Bidder must complete Section 00 45 02 “Affidavit Against Prohibited Acts” prior to execution of the contract by the City of Arlington. Failure to complete this form may prohibit the contractor's ability to secure the contract.

23.02 Apparent low Bidder must complete Section 00 45 03 “Conflict of Interest Questionnaire” prior to execution of the contract by the City of Arlington. Failure to complete this form may prohibit the contractor's ability to secure the contract.

23.03 Apparent low Bidder must complete Section 00 45 04 “Verification Relating to Boycotting Israel” prior to execution of the contract by the City of Arlington. State legislation, Chapter 2270 of the Texas Government Code prevents the City of Arlington from contracting with companies that boycotts Israel or engage subcontractors or suppliers that boycott Israel. The successful contractor must verify they do not and will not boycott Israel during term of this contract. Failure to complete this form will prevent the contractor from securing the contract.

23.04 Apparent low Bidder must complete Section 00 45 05 “Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations” prior to execution of the contract by the City of Arlington. State legislation, Chapter 2252, Subchapter F of the Texas Government Code prohibits the City of Arlington from contracting with companies that engage in business with Iran, Sudan, or foreign terrorist organizations. The successful contractor must verify they do not and will not engage in business with Iran, Sudan, or foreign terrorist organizations during term of this contract. Failure to complete this form may prohibit the contractor's ability to secure the contract.

ARTICLE 24 – PROCUREMENT OF GOODS AND SERVICES FROM ARLINGTON BUSINESSES

24.01 In performing this contract, Contractor agrees to use diligent efforts to purchase all goods and services from Arlington Businesses whenever such goods and services are comparable in availability, quality and price.

ARTICLE 25 – PROCUREMENT OF GOODS AND SERVICES FROM MINORITY/WOMEN BUSINESS ENTERPRISE OR HISTORICALLY UNDERUTILIZED BUSINESSES

25.01 As a matter of policy with respect to City of Arlington projects and procurements, City of Arlington also encourages the use, if applicable, of qualified contractors, subcontractors and

suppliers where at least fifty-one percent (51%) of the Ownership of such contractor, subcontractor or supplier is vested in racial or ethnic minorities or women. In the selection of subcontractors, suppliers or other persons in organizations proposed for work on this contract, the Contractor agrees to consider this policy and to use its reasonable and best efforts to select and employ such company and persons for work on this contract. The Contractor also agrees to provide information about its minority status with the Bid Proposal per Section 00 43 16 "Prime, Subs & Minority/Women Business Enterprise (MWBE) Report." In addition, the Contractor will be required to submit cost information related to minority/woman businesses in accordance with Section 00 73 39 "Minority/Women Business Enterprise Participation Program."

25.02 Information required per Paragraph 25.01 is required with each monthly Application for Payment. No information is to be submitted with the Bid.

ARTICLE 26 – BID TABULATION

26.01 A tabulation of all bids will be available on City's web page http://www.arlington-tx.gov/finance/purchasing/bidding-procurement/public-works- transportation-bidding-opportunities/ within five (5) working days of the bid opening.

ARTICLE 27 – ADDENDA

27.01 The Owner reserves the right to issue addenda to the Contract Documents. Bidders who are current registered vendors with the City's Supplier Portal will be notified via the portal notification process and the addenda may be downloaded from the Supplier Portal. Bidders who obtained the bid documents from the Map Room will receive the addenda via email.

27.02 Bidder is responsible for being aware of all addenda issued by the Owner.

ARTICLE 28 – TITLE V OF CIVIL RIGHTS ACT

28.01 The City of Arlington, in accordance with Title VI of the Civil Rights Act of 1964, 78 Stat. 252, 42 U.S.C. 2000d to 2000d-4 and Title 49, Code of Federal Regulations, Department of Transportation, Subtitle A, Office of the Secretary, Part 21, Nondiscrimination in Federally-Assisted programs of the Department of Transportation issued pursuant to such Act, hereby notifies all vendors that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, minority business enterprises will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award. Vendor will abide and ensure compliance with all terms of Appendix A of the USDOT Standard Title VI Assurances as listed below:

A. Appendix A of the USDOT Standard Title VI Assurances: During the performance of this contract, the contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "contractor") agrees as follows:

1. Compliance with Regulations: The contractor shall comply with the Regulations relative to nondiscrimination in Federally-Assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

2. Nondiscrimination: The contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate either directly or indirectly in the discrimination prohibited by section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

3. Solicitations for Subcontracts, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, or national origin.

4. Information and Reports: The contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the City of Arlington or the Texas Department of Transportation to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information the contractor shall so certify to the City of Arlington, or the Texas Department of Transportation as appropriate, and shall set forth what efforts it has made to obtain the information.

5. Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the City of Arlington shall impose such contract sanctions as it or the Texas Department of Transportation may determine to be appropriate, including, but not limited to:

    a. withholding of payments to the Contractor under the contract until the Contractor complies, and/or

    b. cancellation, termination or suspension of the contract, in whole or in part.

6. Incorporation of Provisions: The Contractor shall include the provisions of paragraphs 1 through 6 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto.

The Contractor shall take such action with respect to any subcontract or procurement as the City of Arlington or the Texas Department of Transportation may direct as a means of enforcing such provisions including sanctions for non-compliance: Provided, however, in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the City of Arlington to enter into such litigation to protect the interests of the City of Arlington, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

ARTICLE 29 – FORM 1295

29.01 Effective January 1, 2016, the Texas Legislature, House Bill 1295 requires all business entity to file an electronic disclosure of interested parties (Form 1295) to the Texas Ethic Commission

(TEC) for any contracts requiring City Council approval. As soon as it's available, the minute order number of the contract will be forwarded to the apparent lowest responsible bidder to complete his filing online with TEC. At that time, the contractor will be required to swear or affirm that the information entered is true and correct. A signed and notarized copy of the filing must be submitted to the City with the executed contracts within the time frame indicated on the award letter. Failure to include Form 1295 with return of the contracts will result in the contracts not being processed.

FAQ's for Form 1295 can be found on the Texas Ethics Commission web page, https://www.ethics.state.tx.us/whatsnew/FAQ_Form1295.htm. Definition of "Interested Party" can be found on Texas Ethics Commission Rules and Definitions website, https://www.ethics.state.tx.us/tec/1295-Info.htm

END OF SECTION

MWBE SPECIAL CONTRACT PROVISIONS:
SEALED BID

POLICY STATEMENT

On March 30, 2021, the Arlington City Council approved the resolution to adopt the City's Minority/Woman Business Enterprise (MWBE) Policy & Procedures Manual. This MWBE Policy seeks to reduce race- and gender-based barriers and foster participation with minority and woman-owned businesses in contracting and procurement opportunities with the City of Arlington by increasing the capacities of such firms to perform as prime vendors and subcontractors as well as suppliers.

The City of Arlington reaffirms that it will not, nor will its contractors, discriminate based on race, age, color, religion, sex, national origin, ancestry, gender, disability, or place of birth in the award and performance of contracts.

Every locally funded contract will be evaluated by the City of Arlington's Office of Business Diversity (OBD) to determine the appropriate method for enhancing MWBE participation, including progress towards the achievement of the annual aspirational MWBE goal and other program objectives.

Procedures for implementation, including good faith efforts requirements, information submitted with bid proposals, reporting procedures, etc., shall be consistent with the procedures utilized in the City's <MWBE Policy & Procedures Manual>.

MWBE PROJECT GOAL

The City's MWBE goal, for this project is **16** %.

Trades identified for this solicitation includes: **Mechanical piping, pump & motor units, Paving (drives & sidewalks), Landscaping, Grading, Excavation Shoring, Structural Concrete (slabs and pump cans), Miscellaneous Concrete, Backfill with select fill, Electrical cable and conduit, Electrical duct bank and manholes, demolition, control system (calibration and programming), Miscellaneous electrical (supports and lighting).**

In making a determination that the contractor has made a good-faith effort to meet the City's MWBE goals, the Office of Business Diversity shall consider specific documentation concerning the steps taken to obtain MWBE participation, with a consideration of the following factors listed on Good Faith Effort Form.

If a contractor fails to submit the Good Faith Efforts checklist, with document, by the deadline for submission will be considered non-responsive.

The contractor's MWBE commitment percentage is based on the total value of the contract including any change orders and modifications throughout the contract agreement.

The criteria used to set a MWBE Contract Specific Goal shall include business availability, the nature of the contract, the City's past experiences with MWBE participation in similar contracts, price competitiveness, subcontracting opportunities, progress towards meeting the annual goal and other relevant factors.

Office of Business Diversity

Good Faith Effort Checklist

In making a determination that the contractor has made a good-faith effort to meet the City's MWBE goals, the Office of Business Diversity shall consider specific documentation concerning the steps taken to obtain MWBE participation, with a consideration of the following factors:

If a contractor fails to submit the Good Faith Efforts checklist, with document, by the deadline for submission will be considered non-responsive.

□ Contractor attended the City's pre-bid or pre-proposal meeting.

□ Contractor advertised in general circulation, trade association, and/or MWBE-focused media regarding subcontracting and/or supplier opportunities.

□ Contractor solicited through reasonable and available means (*e.g.*, written notices, advertisements) M/WBEs certified in the anticipated scopes of subcontracting of the contract, within sufficient time to allow them to respond. Attach detailed Contacts Log, including date, method of contact, person contacted and contact information, and the result of the contact.

□ Contractor selected those portions of the contract consistent with the available M/WBEs, including breaking down the work into economically feasible units to facilitate M/WBE participation even when the proposer would prefer to perform those scopes with its own forces. Provide description of work selected.

□ Contractor provided timely and adequate information about plans, specifications, scope of work and contract requirements to interested MWBEs. Followed up initial solicitations to answer questions and encourage M/WBEs to submit proposals or bids. Attach evidence of information provided, including the date, e.g., letters, emails, telephone logs, etc.

□ Contractor negotiated in good-faith with interested MWBEs that have submitted proposals or bids and thoroughly investigated their capabilities, using good business judgement, and taking into consideration the MWBE subcontractor's price quote and not rejecting reasonable quotes from interested MWBE. Evidence of such negotiations includes the names, addresses, email addresses and telephone numbers of M/WBEs with whom the vendor negotiated; a description of the information provided to M/WBEs regarding the work selected for subcontracting; and explanations as to why agreements could not be reached with M/WBEs to perform the work.

□ Contractor made effort to assist interested MWBEs to obtain bonding, lines of credit, or insurance as required by the City or the vendor for performance of the contract (if applicable).

□ Contractor effectively utilized the services of M/WBE assistance groups; local, state, and federal M/WBE business assistance offices and other organizations that provide assistance in the recruitment and placement of MWBEs.

Signature Prime Contractor: **Print Name:**

Title **Date:**

Office of Business Diversity

LETTER OF INTENT TO SUBCONTRACT

Project Number: _____

Project Title: _____

_____ ("Prime Contractor") agrees to enter into a contractual agreement with _____ ("MWBE Subcontractor"), who will provide the following goods/services on the above-referenced contract.

(Use broad categories (ex. "electrical work", "HVAC equipment purchase", etc.) to describe the goods/services to be provided).

_____

_____

_____

for an estimated amount of $ _____ or 0.0% of the total estimated contract value.

Prime Contractor agrees to utilize said MWBE Subcontractor in the capacity indicated herein and MWBE Subcontractor agrees to work on the above-referenced contract in the capacity herein, contingent upon award of the contract to Prime Contractor.

_____
Signature – Prime Contractor

_____
Print Name

_____
Title Date

_____
Signature – MWBE Subcontractor

_____
Print Name

_____
Title Date

Office of Business Diversity

MWBE UTILIZATION PLAN

Project Name _____

Project No: _____ Date: _____

LEGEND

MWBE = Minority/Woman Business Enterprise

* Ethnicity = Native American (AI), Asian Pacific/Indian (AS), African American (BL), Hispanic (HI), Caucasian Female (WO), or Non- Minority (N/A)

Prime Contractor	MWBE (Yes/No)

LIST ALL SUBCONTRACTING OPPORTUNITIES (use additional sheets if necessary):

Name of Company and Description of Work Type	Potential MWBE Firm Ethnicity* (Yes/No)	Anticipated Dollar ($) of Work

Please complete this form and include with proposal, as an attachment.

Upon formal award of said project, the proposer will submit a Prime, Subs & MWBE Report identifying the Local and/or MWBE subcontractor(s) that will perform the listed work. By signing below, the recommended proposer shall agree to meet their Local and/or MWBE goal based on the information provided on this document.

Name of Company's Main Contact Person _____

Signature of Main Contact Person _____

MINORITY/WOMEN BUSINESS ENTERPRISE

(MWBE)

Minority and/or Woman-owned Business Enterprises are encouraged to participate in all City procurement solicitation. In order to be identified as a certified Minority/Woman Business Enterprise with the City of Arlington, Texas; this form, along with a copy of the selected certification, should be included with the bid/ proposal.

PLEASE CHECK THE APPROPRIATE ETHNICITY AND/OR GENDER:

☐ **American Indian** ☐ **Asian** ☐ **Black** ☐ **Hispanic** ☐ **Woman Owned**

Certification Status: Is the firm certified as a Minority, Woman, or Disadvantaged Business Enterprise by a government or business development agency? Yes No (If yes, please select specific agency)

☐ North Central Texas Regional Certification Agency (NCTRCA)

☐ State of Texas Historically Underutilized Business (HUB)

☐ Dallas/Fort Worth Minority Supplier Development Council (DFW MSDC) or NMSDC affiliate

☐ Women's Business Council – Southwest (WBC-SW) or WBENC affiliate

☐ Texas Department of Transportation, Disadvantaged Business Enterprise (TxDOT, DBE)

☐ Small Business Administration, 8(A) Program

☐ Other (please specify) _____

The City of Arlington encourages minority participation and utilizing MWBE subconsultants where there are opportunities on this project.

For City Use Only:

I have reviewed this Utilization Plan and found that the _____ **HAS** or **HAS NOT** complied as per the City's M/WBE Special Provisions.

Verified Goal attainment:

MBE____% WBE _____%

Reviewer Date:

A contractor cannot require a MWBE to sign an exclusive arrangement for the purpose of a bid/proposal submittal or enter a non-compete arrangement post award.

SUBMITTAL OF REQUIRED DOCUMENTATION

The following documents must be received by the assigned City Project Manager or Department Designee within the allocated times shown in order for the bid or proposal to be considered responsive to the specification. The Offeror shall **DELIVER OR EMAIL** the MWBE documentation to the assigned City Project Manager or Department Designee; a faxed copy will not be accepted.

MWBE Utilization Plan	Received on bid opening date and time.
Good Faith Effort Form and supporting documentation (if participation is less than stated goal)	Received no later than 2:00 pm CST, on the two (2) City business day after the bid opening or proposal due date. Should be sent to agent of record.
Intent to Perform as a Subcontractor	Received no later than 2:00 pm, on the two (2) City business day after the bid opening or proposal due date. Should be sent to agent of record.

Failure to submit the required MWBE documentation, based on the listed time and date, will result in the bid being considered non-responsive.

MWBE CERTIFICATIONS

The City will recognize MWBE companies that have received one or more certifications from the following organizations:

- North Central Texas Regional Certification Agency (NCTRCA),
- State of Texas Historically Underutilized Business (HUB),
- Texas Department of Transportation (TxDOT),
- DFW Minority Supplier Development Council (MSDC), and
- Woman's Business Council Southwest.

The City reserves the right to review, accept, or reject any certification from agencies not listed.

POST AWARD COMPLIANCE

If change orders, amendments, or any Contract modifications are issued, the contractor has a contractual commitment to meet and/or exceed their MWBE utilization goal. Contractor is obligated to immediately notify OBD, in writing, of any agreed increase or decrease in the scope of work that will impact the MWBE participation on the contract.

The Contractor cannot terminate, substitute, or change the terms of the MWBE Utilization Plan prior to or after Contract award without the prior written consent of the OBD. If the Contractor is unable to meet its MWBE commitment with existing MWBEs, the Contractor shall satisfy its commitment, as it relates to scope of work changes, modifications, and or amendments, by soliciting new MWBEs, must submit a **Request for Approval of Change to MWBE Utilization Plan** for review and written approval from the OBD.

All payments must be submitted to our supplier diversity portal B2GNow: https://arlingtontx.diversitycompliance.com/

For vendors who are not users of B2Gnow and would like to be added, please send an email to The Office of Business Diversity mwbe@arlingtontx.gov. Please include your first name, last name, email address, full company address and phone number to be added when you email the City of Arlington. Any missing information will result in your account not being created.

For training on how to utilize B2Gnow, please sign up at https://arlingtontx.diversitycompliance.com/ and click on System Training.

00 41 13 BID FORM

ARTICLE 1 – BID RECIPIENT

1.01 Bidder submits this Bid to:

City of Arlington
Office of the Director of Water Utilities
101 West Abram Street
Arlington, Texas 76010
2nd Floor of City Hall
Attention: Ashley Brown
John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
Project Number WUTR19020

ARTICLE 2 – BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with the Owner on the form included in the Contract Documents and to perform all Work specified or indicated in Contract Documents for the Contract Price indicated in this Bid or as modified by Contract Amendment. Bidder agrees to complete the Work within the Contract Times established in the Agreement or as modified by Contract Amendment and comply with all other terms and conditions of the Contract Documents.

2.02 Bidder accepts all the terms and conditions of the Invitation to Bid and Section 00 21 13 "Instructions to Bidders."

2.03 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of its failure to complete Work in accordance with the schedule set forth in the Agreement.

2.04 Bidder acknowledges receipt of the following Addenda:

Addendum No.	Addendum Date	Signature Acknowledging Receipt

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 Bidder has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

3.02 Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3.03 Bidder is familiar with Laws and Regulations that may affect cost, progress, and performance of the Work.

3.04 Bidder has carefully studied the following Site-related reports and drawings as identified in the Supplementary Conditions:

A. Geotechnical Data Reports regarding subsurface conditions at or adjacent to the Site;

B. Drawings of physical conditions relating to existing surface or subsurface structures at the Site;

C. Underground Facilities referenced in reports and drawings;

D. Reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site; and

E. Technical Data related to each of these reports and drawings.

3.05 Bidder has considered the:

A. Information known to the Bidder;

B. Information commonly known to contractors doing business in the locality of the Site;

C. Information and observations obtained from visits to the Site; and

D. The Contract Documents.

3.06 Bidder has considered the items identified in Paragraphs 3.04 and 3.05 with respect to the effect of such information, observations, and documents on:

A. The cost, progress, and performance of the Work;

B. The means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and

C. Bidder's safety precautions and programs.

3.07 Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents based on the information and observations referred to in the preceding paragraphs.

3.08 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 Contract Documents.

3.09 Bidder has correlated the information known to the Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

3.10 Bidder has given the Construction Manager written notice of all conflicts, errors, ambiguities, or discrepancies that the Bidder has discovered in the Contract Documents, and the written resolution provided by the Construction Manager is acceptable to the Bidder.

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

3.12 Bidder's submittal of a Bid constitutes an incontrovertible representation that, without exception, all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

3.13 Bidder is aware of the provisions of the Texas Penal Code dealing with bribery and gifts to public servants.

3.14 Bidder is not prohibited from being awarded this Contract under Texas Government Code Chapter 2252, Subchapter F which prohibits contracting with companies that engage in business with Iran, Sudan, or foreign terrorist organizations.

3.15 Bidder does not boycott Israel and will not boycott Israel during the term of this Contract if awarded to the Bidder in accordance with Texas Government Code Chapter 2270.

ARTICLE 4 – BASIS OF OFFER

4.01 Bidder will complete the Work in accordance with the Contract Documents at the Contract Price shown in Section 00 41 16 "Bid Form Exhibit A":

4.02 Bidder agrees that the Work will be Substantially Complete and will be completed and ready for final payment in accordance with the General Conditions within the number of calendar days indicated in Section 00 41 16 "Bid Form Exhibit A."

ARTICLE 5 – ATTACHMENTS TO THIS BID

5.01 The following documents are attached to and made a condition of this Bid:

A. Section 00 41 16 "Bid Form Exhibit A."

B. Section 00 43 13 "Bid Bond" or other acceptable Bid Bond form.

C. Section 00 45 01 "Contractor Residency Statement."

D. Section 00 45 02 "Affidavit Against Prohibited Acts."

E. Section 00 45 03 "Conflict of Interest Questionnaire."

F. Section 00 45 04 "Verification Relating to Boycotting Israel."

G. Section 00 45 05 "Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations."

H. Section 00 45 06 "Non-Collusion Certification."

I. Section 00 45 07 "Compliance to State Sales Tax Code."

J. Section 00 45 08 "Prevailing Wage Rate Affidavit."

K. Section 00 45 13 "Qualifications Statement."

ARTICLE 6 – VENUE

6.01 Bidder agrees that venue will lie exclusively in Tarrant County, Texas for any legal action.

ARTICLE 7 – BID DELIVERY

7.01 This Bid is offered by:

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Address for giving notices:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 41 16 Bid Form Exhibit A

Project:	John F. Kubata WTP West High Service Pump Station Pump 4 & 5 Additions		**Project No.:**
Owner:	City of Arlington, Texas		WUTR19020
Engineer:	Arcadis USA, Inc.		
Offeror:			

Base Bid

Item No.	Item Description	Unit	Estimated Quantity	Unit Price	Extended Amount
Items in Base Bid (excluding Allowances) per Section 01 29 01 "Measurement and Basis for Payment"					
A-01	West High Service Pump Station Pump 4 & 5 Additions Project	LS	1		
A	**Total Base Bid Items Amount (Sum of Extended Amounts for each Base Bid Line Item)**				
B	**Add (+) or Deduct (-) (See Note 1)**				
C	**Total Adjusted Base Bid Amount (A plus B)**				
Allowances in Base Bid per Section 01 23 10 "Alternates and Allowances"					
D-01	Owner's Allowance	LS	1	150000	150,000.00
D	**Total Allowance Amount (Sum of Extended Amounts for Each Allowance Line Item)**				$ 150,000.00
E	**Total Base Bid with Allowances (Sum of C and D)**				

Contract Time

L	Bidder agrees to reach Substantial Completion in		days
M	Bidder agrees to reach Final Completion in		days

Cost + Time Evaluation

N	Total Base Bid (Line E)		
O	Bidder Days to Substantial Completion		days
P	Value per Day of Construction	$ -	per day
Q	Value for Days of Construction (O X P)		
R	Basis for Comparison of Bids (N + Q)		

Notes	
1	Provision is made for Bidder to include an addition or deduction in the Bid to reflect any last minute adjustments in price. The addition or deduction, if made, will be applied proportionately to the following Items: **[List Base Bid Items to which the Add or Deduct will be applied.]**

BID SUBMITTED BY: [Name of Bidder]

Bidder: _____

Signature: _____

Printed Name: _____

Title: _____

Date: _____

00 43 13 BID BOND

Bidder as Principal Name: Mailing address (principal place of business):	**Surety** Name: Mailing address (principal place of business):
Owner Name: City of Arlington, Texas Mailing address (principal place of business): 101 West Abram Street Arlington, Texas 76010 Attention Second floor Water Utilities	Physical address (principal place of business): Telephone (Main): Telephone (Claims): Surety's state of incorporation:
Contract Project name and number: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions WUTR19020 Bid Due Date:	***By submitting this bond, Surety affirms it is authorized to do business and licensed to execute bonds in the State of Texas.*** **Local Agent for Surety** Name: Company:
Bond Contract Price Offered: Penal Sum of Bond: 5% of Contract Price offered Date of Bond:	Mailing address (principal place of business): Telephone (Main):
The address of the surety company to which any notice of claim should be sent may be obtained from the Texas Department of Insurance by calling the following toll-free number: 1-800-252-3439.	

Surety and Bidder, intending to be legally bound by this bond, do each cause this bond to be duly executed on its behalf by its authorized officer, agent, or representative. The Bidder and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally to this bond. The condition of this obligation is such that if Owner accepts the Bidder's Bid and Bidder delivers the executed Agreement and the required bonds and evidence of insurance within the time stipulated in the Bidding Documents this obligation is null and void. Payment under this bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner. Venue lies exclusively in Tarrant County, Texas for any legal action.

Bidder as Principal	**Surety**
Signature: _____	Signature: _____
Name: _____	Name: _____
Title: _____	Title: _____
Email: _____	Email: _____ *(Attach Power of Attorney)*

END OF SECTION

00 43 16 PRIME, SUBS & MINORITY/WOMEN BUSINESS ENTERPRISE (MWBE) REPORT

Project Name John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions

Project No. WUTR19020 Date:

LEGEND

*	Answer with "YES" or "NO"		
AI	American Indian	BL	
NW	Native American, Women-Owned	BW	
AS	Asian	HI	
AW	Asian, Women-Owned	HW	
WO	Women Owned	Other	

PRIME CONTRACTOR/CONSULTANT	*Arlington Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount

LIST **ALL** SUBS:

Name of Company & Address	Description of Work Type	*Arl Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount	**For City's Use only** Prequalified (Yes/No/NA)

Name of Company & Address	Description of Work Type	*Arl Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount	**For City's Use only** Prequalified (Yes/No/NA)

END OF SECTION

00 43 33 PROPOSED MAJOR EQUIPMENT FORM

Offeror shall complete and submit this form in accordance with the instructions below.

In the table below, Offeror shall indicate the proposed manufacturer of the associated item(s) proposed for use in the Work, should Offeror be awarded the Contract.

Indicate on this form only proposed manufacturers that are expressly indicated by name in the Bidding Documents. Owner has the right to consider the Bid non-responsive and may reject the Bid if Offeror indicates: (a) a manufacturer other than those expressly named in the Bidding Documents for that item; (b) no proposed manufacturer for one or more items; or (c) more than one proposed manufacturer for a given item. However, Owner is not obligated to reject any Bid for the benefit of any Offeror, prospective Supplier, or other individual or entity.

TABLE OF PROPOSED SUPPLIERS FOR MAJOR ITEMS			
General Description	**Specifications Section No.**	**Proposed Manufacturer**	**Proposed Local Representative**
Vertical Lineshaft Pumps	43 21 13.33		
Pump Motors	40 05 93		
Butterfly Valves	40 05 53		
Check Valves	40 05 53		
Reduced Voltage Soft Starters	26 29 13.16		

END OF SECTION

00 45 01 CONTRACTOR RESIDENCY STATEMENT

The Texas Government Code section 2252.002 governs the awarding of contracts to non-resident bidders. This law provides that, in order to be awarded a contract as low bidder, a non-resident bidder (out-of-state contractor whose corporate office or principal place of business is outside the State of Texas) bid projects in Texas at an amount lower than the lowest Texas resident bidder by the same amount that a Texas resident bidder would be required to underbid a non-resident bidder in order to obtain a comparable contract in the state in which the non-resident's principal place of business is located. The appropriate blanks in the following statement must be filled out by all out-of-state or non-resident bidders in order for those bids to meet specifications. The failure of out-of-state or non-resident contractors to do so will automatically disqualify that bidder. This does not apply to contracts involving Federal Funds.

_____ Initial here if you are Texas Residential Bidder.

_____ Initial here if you are a Non-resident contractor in _____ (give state), our principal place of business, is required to be _____ percent lower than resident bidders by State Law.

BIDDER

_____ By: _____

Company *(Please Print)*

_____ _____

Address *Signature*

_____ _____

City, State, Zip Code *Title (Please Print)*

*The **State Purchasing and General Services Commission** defines Principal Place of Business as follows:

Principal Place of Business in Texas means, for any type of business entity recognized in the **State of Texas**, that the business entity:

-has at least one permanent office located in the State of Texas, from which business activities other than submitting bids to governmental agencies are conducted and from which the bid is submitted, and

-has at least one employee who works in the Texas office

*The Texas Comptroller annually publishes a list showing how each state regulates the award if governmental contracts whose principal place of business is not located in that state. http://comptroller.texas.gov/

END OF SECTION

00 45 02 AFFIDAVIT AGAINST PROHIBITED ACTS

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions

I hereby affirm that I am aware of the provisions of the Texas Penal Code Sec. 36.02, 36.08, 36.09, and 36.10 (a copy of which follows), dealing with Bribery and Gifts to Public Servants. I further affirm that I will adhere to such rules and instruct and require all agents, employees, and sub-contractors to do the same. I am further aware that any violation of these rules subjects this agreement to revocation, my removal from bid lists, prohibiting future contract/subcontract work, revocation of permits, and prosecution.

Signed this _____ day of _____ 20 _____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Business Address:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

TEXAS PENAL CODE

TITLE 8: OFFENSES AGAINST PUBLIC ADMINISTRATION

CHAPTER 36. Bribery and Corrupt Influence

36.02 Bribery

(a) A person commits an offense if he intentionally or knowingly offers, confers, or agrees to confer on another, or solicits, accepts, or agrees to accept from another:

(1) any benefit as consideration for the recipient's decision, opinion, recommendation, vote, or other exercise of discretion as a public servant, party official, or voter;

(2) any benefit as consideration for the recipient's decision, vote, recommendation, or other exercise of official discretion in a judicial or administrative proceeding;

(3) any benefit as consideration for a violation of a duty imposed by law on a public servant or party official; or

(4) any benefit that is a political contribution as defined by Title 15, Election Code, or that is an expenditure made and reported in accordance with Chapter 305, Government Code, if the benefit was offered, conferred, solicited, accepted, or agreed to pursuant to an express agreement to take or withhold a specific exercise of official discretion if such exercise of official discretion would not have been taken or withheld but for the benefit; notwithstanding any rule of evidence or jury instruction allowing factual inferences in the absence of certain evidence, direct evidence of the express agreement shall be required in any prosecution under this subdivision.

(b) It is no defense to prosecution under this section that a person whom the actor sought to influence was not qualified to act in the desired way whether because he had not yet assumed office or he lacked jurisdiction or for any other reason.

(c) It is no defense to prosecution under this section that the benefit is not offered or conferred or that the benefit is not solicited or accepted until after:

(1) the decision, opinion, recommendation, vote, or other exercise of discretion has occurred; or

(2) the public servant ceases to be a public servant.

(d) It is an exception to the application of Subdivisions (1), (2), and (3) of Subsection (a) that the benefit is a political contribution as defined by Title 15, Election Code, or an expenditure made and reported in accordance with Chapter 305, Government Code.

(e) An offense under this section is a felony of the second degree.

36.08 Gift to Public Servant by Person Subject to His Jurisdiction

(a) A public servant in an agency performing regulatory functions or conducting inspections or investigations commits an offense if he solicits, accepts, or agrees to accept any

benefit from a person the public servant knows to be subject to regulation, inspection, or investigation by the public servant or his agency.

(b) A public servant in an agency having custody of prisoners commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows to be in his custody or the custody of his agency.

(c) A public servant in an agency carrying on civil or criminal litigation on behalf of government commits an offense if he solicits, accepts, or agrees to accept any benefit from a person against whom the public servant knows litigation is pending or contemplated by the public servant or his agency.

(d) A public servant who exercises discretion in connection with contracts, purchases, payments, claims, or other pecuniary transactions of government commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows is interested in or likely to become interested in any contract, purchase, payment, claim, or transaction involving the exercise of his discretion.

(e) A public servant who has judicial or administrative authority, who is employed by or in a tribunal having judicial or administrative authority, or who participates in the enforcement of the tribunal's decision, commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows is interested in or likely to become interested in any matter before the public servant or tribunal.

(f) A member of the legislature, the governor, the lieutenant governor, or a person employed by a member of the legislature, the governor, the lieutenant governor, or an agency of the legislature commits an offense if he solicits, accepts, or agrees to accept any benefit from any person.

(g) A public servant who is a hearing examiner employed by an agency performing regulatory functions and who conducts hearings in contested cases commits an offense if the public servant solicits, accepts, or agrees to accept any benefit from any person who is appearing before the agency in a contested case, who is doing business with the agency, or who the public servant knows is interested in any matter before the public servant. The exception provided by Sec. 36.10(b) does not apply to a benefit under this subsection.

(h) An offense under this section is a Class A misdemeanor.

(i) A public servant who receives an unsolicited benefit that the public servant is prohibited from accepting under this section may donate the benefit to a governmental entity that has the authority to accept the gift or may donate the benefit to a recognized tax-exempt charitable organization formed for educational, religious, or scientific purposes.

36.09 Offering Gift to Public Servant

(a) A person commits an offense if he offers, confers or agrees to confer any benefit on a public servant that he knows the public servant is prohibited by law from accepting.

(b) An offense under this section is a Class A misdemeanor.

36.10 Non-Applicable

(a) Sections 36.08 (Gift to Public Servant) and 36.09 (Offering Gift to Public Servant) do not apply to:

(1) a fee prescribed by law to be received by a public servant or any other benefit to which the public servant is lawfully entitled or for which he gives legitimate consideration in a capacity other than as a public servant;

(2) a gift or other benefit conferred on account of kinship or a personal, professional, or business relationship independent of the official status of the recipient; or

(3) a benefit to a public servant required to file a statement under Chapter 572, Government Code, or a report under Title 15, Election Code, that is derived from a function in honor or appreciation of the recipient if:

(A) the benefit and the source of any benefit in excess of $50 is reported in the statement; and

(B) the benefit is used solely to defray the expenses that accrue in the performance of duties or activities in connection with the office which are nonreimbursable by the state or political subdivision;

(4) a political contribution as defined by Title 15, Election Code;

(5) a gift, award, or memento to a member of the legislative or executive branch that is required to be reported under Chapter 305, Government Code;

(6) an item with a value of less than $50, excluding cash or a negotiable instrument as described by Section 3.104, Business & Commerce Code; or

(7) an item issued by a governmental entity that allows the use of property or facilities owned, leased, or operated by the governmental entity.

(b) Section 36.08 (Gift to Public Servant) does not apply to food, lodging, transportation, or entertainment accepted as a guest and, if the donee is required by law to report those items, reported by the donee in accordance with that law.

(c) Section 36.09 (Offering Gift to Public Servant) does not apply to food, lodging, transportation, or entertainment accepted as a guest and, if the donor is required by law to report those items, reported by the donor in accordance with that law.

(d) Section 36.08 (Gift to Public Servant) does not apply to a gratuity accepted and reported in accordance with Section 11.0262, Parks and Wildlife Code. Section 36.09 (Offering Gift to Public Servant) does not apply to a gratuity that is offered in accordance with Section 11.0262, Parks and Wildlife Code.

END OF SECTION

CONFLICT OF INTEREST QUESTIONNAIRE — FORM CIQ

For vendor doing business with local governmental entity

This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176 of the Local Government Code by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. See Section 176.006(a-1), Local Government Code.

A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.

OFFICE USE ONLY

Date Received

1 **Name of vendor who has a business relationship with local governmental entity.**

2 ☐ **Check this box if you are filing an update to a previously filed questionnaire.** (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)

3 **Name of local government officer about whom the information is being disclosed.**

Name of Officer

4 **Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary.**

A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor?

☐ Yes ☐ No

B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity?

☐ Yes ☐ No

5 **Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more.**

6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1)

7

Signature of vendor doing business with the governmental entity

Date

Form provided by Texas Ethics Commission www.ethics.state.tx.us Revised 11/30/2015

CONFLICT OF INTEREST QUESTIONNAIRE
For vendor doing business with local governmental entity

A complete copy of Chapter 176 of the Local Government Code may be found at http://www.statutes.legis.state.tx.us/Docs/LG/htm/LG.176.htm. For easy reference, below are some of the sections cited on this form.

Local Government Code § 176.001(1-a): "Business relationship" means a connection between two or more parties based on commercial activity of one of the parties. The term does not include a connection based on:

(A) a transaction that is subject to rate or fee regulation by a federal, state, or local governmental entity or an agency of a federal, state, or local governmental entity;

(B) a transaction conducted at a price and subject to terms available to the public; or

(C) a purchase or lease of goods or services from a person that is chartered by a state or federal agency and that is subject to regular examination by, and reporting to, that agency.

Local Government Code § 176.003(a)(2)(A) and (B):

(a) A local government officer shall file a conflicts disclosure statement with respect to a vendor if:

***

(2) the vendor:

(A) has an employment or other business relationship with the local government officer or a family member of the officer that results in the officer or family member receiving taxable income, other than investment income, that exceeds $2,500 during the 12-month period preceding the date that the officer becomes aware that

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor;

(B) has given to the local government officer or a family member of the officer one or more gifts that have an aggregate value of more than $100 in the 12-month period preceding the date the officer becomes aware that:

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor.

Local Government Code § 176.006(a) and (a-1)

(a) A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with a local governmental entity and:

(1) has an employment or other business relationship with a local government officer of that local governmental entity, or a family member of the officer, described by Section 176.003(a)(2)(A);

(2) has given a local government officer of that local governmental entity, or a family member of the officer, one or more gifts with the aggregate value specified by Section 176.003(a)(2)(B), excluding any gift described by Section 176.003(a-1); or

(3) has a family relationship with a local government officer of that local governmental entity.

(a-1) The completed conflict of interest questionnaire must be filed with the appropriate records administrator not later than the seventh business day after the later of:

(1) the date that the vendor:

(A) begins discussions or negotiations to enter into a contract with the local governmental entity; or

(B) submits to the local governmental entity an application, response to a request for proposals or bids, correspondence, or another writing related to a potential contract with the local governmental entity; or

(2) the date the vendor becomes aware:

(A) of an employment or other business relationship with a local government officer, or a family member of the officer, described by Subsection (a);

(B) that the vendor has given one or more gifts described by Subsection (a); or

(C) of a family relationship with a local government officer.

Form provided by Texas Ethics Commission www.ethics.state.tx.us Revised 11/30/2015

END OF SECTION

00 45 04 VERIFICATION RELATING TO BOYCOTTING ISRAEL

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
WUTR19020

The State of Texas has passed legislation which is codified in Chapter 2270 of the Texas Government Code that prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor by signing below verifies that Contractor does not boycott Israel and will not boycott Israel during the term of the Contract. This verification when executed will be attached to the contract and become a part of the contract for all purposes.

Signed this _____ day of _____ 20 _____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Business Address:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 05 PROHIBITION ON CONTRACTS WITH COMPANIES ENGAGED IN BUSINESS WITH IRAN, SUDAN, OR FOREIGN TERRORIST ORGANIZATIONS

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
WUTR19020

State legislation, Chapter 2252, Subchapter F of the Texas Government Code prohibits any municipal government from entering into a contract for goods and services with companies that engage in business with Iran, Sudan, or foreign terrorist organizations. The Contractor, by signing below, verifies that Contractor does not engage in business with Iran, Sudan, or foreign terrorist organizations and will not engage in business with Iran, Sudan, or foreign terrorist organizations during the term of the Contract. This verification when executed will be attached to the contract and become a part of the contract for all purposes.

Signed this _____ day of _____ 20 _____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Business Address:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 06 NON-COLLUSION CERTIFICATION

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
WUTR19020

Bidder certifies that it has not been a party to any collusion among Bidders in the restraint of freedom of competition by agreement to submit a Bid at a fixed price or to refrain from submitting a Bid or with any official or employee of the Owner as to quantity, quality, or price in the prospective contract, or any other terms of said prospective contract; or in any discussion between Bidders and any official of the Owner concerning exchange of money or other thing of value for special consideration in the letting of a contract.

Certified this _____ day of _____ 20 _____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Business Address:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 07 COMPLIANCE TO STATE SALES TAX CODE

Comply with all applicable sales, excise, and use tax requirements of the Texas Tax Code. The Bidder hereby certifies that the Contract Price is divided as follows:

Tax exempt products, materials, and services (See Notes 1 and 2) $ _____

Taxable products, materials, and services (See Note 3) $ _____

Total (See Note 4) $ _____

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Business Address:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

Notes:

1. Exempt products and materials are those items purchased for the Project which are physically incorporated into the facilities constructed for the Owner or are necessary and essential for the performance of the Work and are completely consumed at the Site. For purposes of this definition, products and materials are completely consumed if after being used once for its intended purpose it is used up or destroyed. Products and materials rented or leased for use in the performance of the Work cannot be completely consumed for the purposes of this definition.
2. Exempt services are those services performed at the Site where the Contract expressly requires the specific service to be provided or purchased by the person performing the Work or the service is integral to the performance of the Work.
3. Products, materials, and services are not tax exempt if they are used by the Contractor but are not physically incorporated into the Owner's facilities or are not consumed by construction as defined above. Machinery or equipment and its accessories and repair and replacement parts used in the performance of the Work are not exempt.
4. The total sum of the amount for tax exempt and taxable products, materials, and services must equal the Contract Price.

END OF SECTION

00 45 08 PREVAILING WAGE RATE AFFIDAVIT

STATE OF Texas

COUNTY OF Tarrant

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
WUTR19020

BEFORE ME, the undersigned authority, a Notary Public in and for the State of Texas, on this day personally appeared _____,

☐ who is known to me

☐ who was proved to me on the oath of _____ (name of person identifying the acknowledging person) or

☐ who was proved to me through _____ (description of identity card or other document issued by the federal or state government containing the picture and signature of the acknowledging person) to be the person whose name is subscribed to this affidavit; and being by me first duly sworn, upon oath stated as follows:

"My name is _____. I am of sound mind and capable of making this affidavit.

"I am _____ for _____, which company entered into a contract on the ____ day of _____ 20____ , to construct John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions, City of Arlington Project No. WUTR19020, in the City of Arlington, Texas, and I am duly authorized on behalf of said company to hereby swear and affirm that all wages for labor on the above-referenced project are in strict compliance with the established prevailing wage rates as described in the contract documents for the referenced project, and all wages have been and will be paid and satisfied as the prevailing rates may change from time to time. Upon request by the City of Arlington, I shall allow a complete examination of the financial records relative to this project, including, but not limited to, cancelled checks, invoices and statements at any time, and allow the City of Arlington to interview any and/or all employees of the above said company or any and/or all employees of said Company's subcontractor or subcontractors. Also, I hereby agree on behalf of the above company, to be accountable for any and all penalties and/or fine provisions in accordance with the contract documents and relevant law."

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____

_____
(typed or printed)

Representing: _____
(typed or printed name of organization)

Notary Attest
Sworn to (or affirmed) and subscribed before me this _____ day of _____ , _____
(month) *(year)*

☐ Personally Known ☐ Produced Identification Type and No. of ID: _____

By: _____
(notary's signature)

Name: _____
(typed or printed)

Notary Public - State of: _____
(typed or printed)

My Commission expires: _____
(typed or printed) *(notary seal)*

END OF SECTION

00 45 13 QUALIFICATIONS STATEMENT

ARTICLE 1 – REQUIREMENTS FOR THE QUALIFICATIONS STATEMENT

1.01 The Qualifications Statement must be submitted by the apparent low Bidder with the bid and include the information as described in this Section as a minimum. Failure to submit the required information in the Qualifications Statement may result in the Owner considering the Bid non-responsive and may result in rejection of the Bid by the Owner. Bidders may be required to provide supplemental information if requested by the Owner to clarify, enhance, or supplement the information provided in the Qualifications Statement.

1.02 Bidders must provide the information requested in this Qualifications Statement using the forms attached to this Section. The information requested in these forms must be provided completely and in detail. Information that cannot be totally incorporated in the forms may be included as an appendix to the form. This appendix must be clearly referenced by appendix number on the form, and the appended material must include the appendix number on every sheet of the appendix. The appendix must include only the information that responds to the question or item number to which the appended information applies.

1.03 Bidders may provide supplemental information to the Qualifications Statement such as organizational brochures or other marketing information to help demonstrate their qualifications to the Owner. This information may not be submitted as a substitute for the information specifically requested in this Section. The reference must include the specific paragraph or section that applies to that question or item if this information is included as an appendix to the information requested in Article 2.

ARTICLE 2 – INSTRUCTIONS FOR PREPARING THE QUALIFICATIONS STATEMENT

2.01 Bidder's Organization and General Information:

A. Provide general information about the Bidder's organization using copies of Table 1. Provide the same information for each joint venture partner if the Bidder is a joint venture.

B. Provide information regarding the operational structure of the Bidder's organization, including a list of officers, the limits of authority for these individuals with regards to the proposed Project, documentation of authority to execute documents, and a copy of organizations' certificate of authorization to conduct business in the state of Texas.

C. Financial Management:

1. Provide Bidder's most recent audited financial statement and the most recent financial statement if the most recent audited financial statement is more than 2 years old.

2. Provide the Bidder's financial summary information in Table 1, including the financial indicators from the Bidder's most recent financial statement using the formulas below:

Current Ratio: Current Assets ÷ Current Liabilities

Quick Ratio: (Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities

3. Describe the resources that are available to the Bidder to provide adequate cash flow for the project if Bidder's Current Ratio or Quick Ratio are less than 1.0.

D. Safety:

1. Provide a narrative not to exceed four pages describing the organizations success in implementing an effective project site safety program. Provide a narrative describing the Bidder's safety program and a statement regarding the organization's commitment to safety. Bidders should not provide copies of safety manuals or programs.

2. Provide Experience Modification Ratio (EMR) and Total Recordable Frequency Rate (TRFR) history for the last 3 years for the Bidder and any proposed Subcontractors that will provide Work valued at 25 percent or more of the Contract Price. Provide this information in Table 1.

   a. The Bidder's EMR is a computation by the insurance industry that compares a company's annual losses in workers' compensation insurance claims against its policy premiums over a three-year period, excluding the current year.

   b. The Bidder's TRFR is a calculation of a firm's total number of OSHA-recordable injuries and illnesses over a given period (usually a year), divided by the total number of personnel-hours worked.

E. Claims Experience and Litigation History: Provide a list of all claims or litigation involving owners on other construction projects that have been active over the last 5 years or that are currently unresolved. Include this information in Table 1. Provide a narrative describing the issues being contested and when it is anticipated that the disputes will be resolved. Claims are to include only those items which have progressed through the change management process for the project and are being disputed by the Bidder or the project owner.

F. Past Experience with the Owner: Provide a list of projects that have been completed with the Owner over the last 5 years. Include this information in Table 1. Provide a narrative not to exceed two pages describing how this experience will impact the performance of the organization on this Project.

2.02 Project Experience:

A. Provide a list of projects completed by the Bidder in the last 5 years using copies of Table 2.

B. Provide detailed descriptions of projects which demonstrate the experience of the Bidder's team with construction of similar projects. Experience must include, as a minimum, the satisfactory completion of at least 5 similar projects within the last 5 years. Companies not meeting this requirement for similar projects may be disqualified as being non-responsive. Similar projects must include:

1. Vertical turbine pump installation including electrical, controls & start-up.

C. Provide a narrative not to exceed two pages for each project describing up to five specific projects that qualify as similar projects. Projects selected must demonstrate the capabilities of the organization.

2.03 Experience and Qualifications of Proposed Key Personnel:

A. Provide a narrative not to exceed four pages describing the Bidder's project management structure and the qualifications of the project management team for this Project. Include an organization chart showing the relationship between Bidder and key Subcontractors and Suppliers.

B. Provide information on the key personnel proposed for this project on Tables 3 through 4. Key personnel include the Project Manager and Project Superintendent. The Bidder may provide information on an alternate individual if the Bidder is not able to commit to one individual for the Project at the time the Bid is submitted. Qualifications of these individuals will be considered in evaluating the qualifications of the Bidder. The Bidder must commit to providing the services of the proposed key personnel or alternate for the life of the Project as a condition of qualification. Failure to provide the proposed key personnel may result in the disqualification of the Bidder and will provide the basis for termination of the Contract at the discretion of the Owner.

C. Include a list of the current project assignments for each of the individuals proposed, the anticipated completion date for this assignment and the percentage of the time they will have available to devote to this Project. The Project Superintendent must be dedicated to this Project full time for the duration of the Project. If any other key personnel are not devoted solely to this Project, indicate how time is to be divided between this Project and their other assignments. Specifically address how and when individuals currently on other assignments will transition into this Project.

D. Provide resumes not exceeding two pages for each individual proposed for the key personnel positions and their alternates. Resumes must describe the qualifications of the individual and include the following as a minimum: technical experience, managerial experience, education and formal training, primary language, and a work history which describes project experience, including the roles and responsibilities for each assignment. Additional information highlighting the experience which makes them the best candidate for the assignment should also be included. Focus on projects on which individuals proposed have had significant involvement in the last 5 years and which demonstrate their experience with similar projects.

E. Identify individuals that will fill one or more of these key roles and describe their ability to handle multiple responsibilities. Provide a written narrative describing the percentage of the time that will be devoted to each role and their qualifications to fulfill each role if an individual is to fulfill more than one of the key personnel roles.

F. Provide a narrative not to exceed two pages for each project the proposed individuals have worked on that qualify as similar projects. Specifically identify the role and responsibilities of the individual on these similar projects. Projects selected must demonstrate the capabilities of the proposed key personnel.

ARTICLE 3 – QUALIFICATIONS STATEMENT REQUIREMENTS

3.01 Provide the Qualifications Statement using the referenced tables and narrative descriptions as described in this Section. Pages are to be 8-1/2 x 11 pages using a minimum font size of 10. Provide a tab to separate materials responding to each of the rating categories listed in Article 2.

3.02 Additional information may be included in appendices attached to the Qualifications Statement. Each appendix must reference the section of the criteria to which it references.

ARTICLE 4 – FORMS

4.01 The following tables are attached to this Section:

Table	Description
1	General Information
2	Current Projects and Project Completed within the last 5 Years
3	Proposed Project Managers
4	Proposed Project Superintendents

ARTICLE 5 – CERTIFICATION

5.01 By submitting this Qualifications Statement and related information, Bidder certifies that it has read this Qualifications Statement and that Bidder's responses are true and correct and contain no material misrepresentations, and that the individual signing below is authorized to make this certification on behalf of the Bidder's organization.

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Designated Representative:

Name: _____

Title: _____

Address for giving notices:

_____

_____

_____

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

Table 1 - General Information

Organization			
Legal Name of Business:			
Form of Business: ☐ Joint Venture ☐ Corporation ☐ General Partnership ☐ Limited Partnership			
Date Business was formed:		State under which Business was formed:	
Is this Business authorized to operate in the Project location: ☐ Yes ☐ No ☐ Pending			
Is this Business licensed as a general contractor in the Project location: ☐ Yes ☐ No ☐ Pending ☐ N/A			
List of companies, firms, or organizations that own any part of this Business.			
Name of company, firm, or organization.			Percent ownership
Principal Office			
Primary contact		Main telephone number	
Email address		Website address	
Business address of principal office			
Regional Office			
Primary contact		Main telephone number	
Email address		Website address	
Business address of regional office			

Business History		
List of names that this Business currently has or anticipates operating under over the history of the Business, including the names of related companies presently doing business:		
Names of organization	From date	To date

Indicators of Organization Size	
Average number of current full-time employees	
Average estimate of revenue for the current year	

Table 1 - General Information Cont'd

Previous Contracting Experience			
Years of experience in projects similar to the proposed project:			
As a general contractor		As a joint venture partner	
Has this or a participating or a predecessor organization ever been disqualification as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this, a participating or a predecessor organization been released from a bid in the past 5 years?☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever defaulted on a project or failed to complete any contract awarded to it? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Is this or a participating or a predecessor organization currently involved in any litigation or contemplating litigation? ☐ Yes ☐ No If yes provide full details in a separate attachment.			

Previous History with Owner		
List projects that have been completed with the Owner over the last 5 years. If more than 5 projects, list only the most recent.		
	Project Name	Year
1		
2		
3		
4		
5		

Previous Claims History and Litigation Experience		
List all claims or litigation involving owners on other construction projects that have been active over the last 5 years or that are currently unresolved.		
	Description of Claim or Litigation	Status
1		
2		
3		
4		
5		

Table 1 - General Information Cont'd

Surety			
Surety Name			
Mailing address (principal place of business):		Physical address (principal place of business):	
Telephone (main number)		Telephone (claims notices)	
Name of Local Agent for Surety			
Telephone		Email	
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location? ☐ Yes ☐ No			
Is surety listed in the U.S. Department of the Treasury's Listing of Approved Sureties (Department Circular 570 "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies")? ☐ Yes ☐ No			
Insurance			
Name of Insurance Provider			
Provider is a corporation organized and existing under the laws of the state of:			
Is Provider licensed or authorized to issue insurance policies in the Project location?		☐ Yes ☐ No	
Does Provider have an A.M. Best Rating of A-VIII or Better?		☐ Yes ☐ No	
Mailing Address (principal place of business)			
Physical Address (principal place of business)			
Telephone (Main)			
Telephone (for Notice of Claims)			
Local Agent for Provider			
Address for Local Agent			
Telephone for Local Agent			

Construction Site Safety Experience

Provide Bidder's Experience Modification Ratio (EMR) and Total Recordable Frequency Rate (TRFR) for the last 3 years and the EMR and TRFR history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 25% or more of the Contract Price.

Year	Bidder		Subcontractor		Subcontractor		Subcontractor	
	EMR	TRFR	EMR	TRFR	EMR	TRFR	EMR	TRFR
1								
2								
3								

Table 1 - General Information Cont'd

Financial Summary Information for Bidder	
Date of Bidder's most current financial statement:	
Date of Bidder's most current audited financial statement:	
Financial indicators from the most current financial statement:	
Bidder's Current Ratio (Current Assets / Current Liabilities)	
Bidder's Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) / Current Liabilities))	
Describe the resources that are available to the Bidder to provide adequate cash flow for the project if Bidder's Current Ratio or Quick Ratio are less than 1.0:	

Disadvantaged Business Certifications			
Name of Certification		Certifying Agency	Certification Date
☐ Disadvantage Business Enterprise:			
☐ Minority Business Enterprise:			
☐ Woman Business Enterprise:			
☐ Disabled Veteran Owned Business:			
☐ Historically Underutilized Business:			
☐ Small Business Enterprise:			
☐ Other:			
☐ None			

Table 2 - Current Projects and Project Completed within the last 5 Years

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent		Safety Manager	Quality Control Manager
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent		Safety Manager	Quality Control Manager
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent		Safety Manager	Quality Control Manager
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Table 3 - Proposed Project Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Table 4 - Proposed Project Superintendents

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

00 52 13 AGREEMENT

This Agreement is between City of Arlington, Texas (Owner) and **[name of Contractor to be inserted at time of contract execution]** (Contractor).

Owner and Contractor agree as follows:

ARTICLE 1 – WORK

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

John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
Project Number WUTR19020

ARTICLE 2 – ENGINEER

2.01 The Engineer for this Project is:

Arcadis USA, Inc.
630 Plaza Drive, Suite 200
Highlands Ranch, CO 80129

ARTICLE 3 – CONSTRUCTION MANAGER

3.01 The Construction Manager for this Project is:

Arcadis USA, Inc.
630 Plaza Drive, Suite 200
Highlands Ranch, CO 80129

ARTICLE 4 – CONTRACT TIMES

4.01 Contract Times:

A. The Work is required to be substantially complete within the number of calendar days shown in Section 00 52 16 “Agreement Exhibit A” and the project is to be complete and ready for final payment in accordance with the General Conditions within 30 days after the date of Substantial Completion.

B. Critical Operations, maximum time out of service, and associated liquidated damages are as defined in Section 01 35 00 “Special Procedures.”

4.02 Liquidated Damages:

A. Owner and Contractor recognize that the Contract Times specified for Critical Operations, and Substantial Completion and Final Completion are of the essence in the Contract. Owner and Contractor recognize that the Owner will suffer financial loss if the Work is not completed within the Contract Times specified in this Agreement and in Section 01 35 00 “Special Procedures” as may be adjusted in accordance with the General Conditions. Owner and Contractor also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration preceding the actual loss suffered by Owner if the Work is not

completed within the Contract Times. Accordingly, instead of requiring proof of the amount of these damages, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor agrees to pay Owner $500 for each day that expires after the time specified in this Agreement for Substantial Completion until the Work is substantially complete.

B. Contractor agrees to pay the Owner liquidated damages as stipulated in Section 01 35 00 "Special Procedures" for failure to meet Contract Times for Milestones or Critical Operations.

C. OPT will determine whether the Work has been completed within the Contract Times. Assessment of liquidated damages by the Owner does not waive the Owner's right to assess or collect additional damages which the Owner may sustain by the failure of the Contractor to perform in accordance with the terms of the Contract.

4.03 Actual Damages:

A. Owner may be subject to additional financial losses as the result of permit violations or loss of service to City of Arlington customers**.** These losses were not included in the liquidated damages amount established in this Agreement. Contractor will be required to compensate the Owner for these losses if they occur due to the Contractor's failure to reach Substantial Completion by the date specified in this Agreement.

4.04 No Waiver

A. Nothing in this Article shall be considered a waiver of any other damages which Owner may show themselves to be entitled under the Contract or in law.

ARTICLE 5 – CONTRACT PRICE

5.01 Owner will pay Contractor for completion of the Work in accordance with the Contract Documents at the prices shown in Section 00 52 16 "Agreement Exhibit A". The Contract Price has been computed in accordance with the General Conditions. Contractor acknowledges that for unit price items, estimated quantities are not guaranteed and are solely for the purpose of comparing Bids, and that final payment will be based on actual quantities determined in accordance with the Contract Documents.

ARTICLE 6 – PAYMENT PROCEDURES

6.01 Submit Applications for Payment in accordance with the General Conditions. Applications for Payment will be processed by the Construction Manager per Section 01 29 00 "Application for Payment Procedures." Payment is based on the total earned value of Work completed in the previous month in accordance with the Schedule of Values.

6.02 Payment will be made for the total earned value of Work completed in the previous month after deducting:

A. Retainage calculated per this Agreement;

B. Set-offs determined in accordance with the General Conditions; and

C. The total amount of payments previously made.

6.03 Progress payments will be made in an amount equal to 95 percent of the total earned value to date for completed Work and properly stored materials. The remaining 5 percent of the total earned value to date will be held as retainage. Owner may increase retainage to 10 percent if progress on the Project is considered to be unsatisfactory. Owner will deposit retainage in excess of 5 percent in an interest-bearing account. Interest earned by that account will be paid to the Contractor in accordance with Texas Government Code Chapter 2252.

6.04 Release or reduction in retainage is contingent upon the consent of surety to the reduction in retainage. Submit a Consent of Surety Company to Reduction of or Partial Release of Retainage form as provided by or approved by the Construction Manager.

6.05 Owner will pay the remainder of the Contract Price as recommended by Construction Manager in accordance with the General Conditions upon Final Completion and acceptance of the Work.

ARTICLE 7 – PAYMENT OF INTEREST

7.01 All moneys not paid when due as provided in the General Conditions will earn interest at the rate specified in Texas Government Code Chapter 2251. Interest accrual will cease upon payment by the Owner.

ARTICLE 8 – TEXAS GOVERNMENT CODE CHAPTER 552

8.01 Compliance with Texas Government Code Chapter 552:

A. In this section, Contracting Information shall have the same meaning as defined in Texas Government Code § 552.003(7).

B. The Contractor must preserve all Contracting Information related to the contract as provided by the records retention requirements applicable to the governmental body for the duration of the contract;

C. The Contractor must promptly provide to the governmental body any Contracting Information related to the contract that is in the custody or possession of the entity on request of the governmental body; and

D. On completion of the contract, Contractor shall either

1. Provide at no cost to the Owner all Contracting Information related to the contract that is in the custody or possession of the Contractor; or

2. Preserve the Contracting Information related to the contract as provided by the records retention requirements applicable to the City of Arlington.

E. The requirements of Subchapter J, Chapter 552, Government Code, may apply to this contract and the contractor or vendor agrees that the contract can be terminated if the contractor or vendor knowingly or intentionally fails to comply with a requirement of that subchapter.

ARTICLE 9 – RIGHT TO AUDIT

9.01 Contractor agrees that City shall, until the expiration of three (3) years after final payment under this contract, have access to and the right to examine any directly pertinent books, documents, papers and records of Contractor involving transactions relating to this contract. Contractor

agrees that City shall have access during normal working hours to all necessary Contractor facilities and shall be provided adequate and appropriate workspace in order to conduct audits in compliance with the provisions of this section. City shall give Contractor reasonable advance notice of intended audits.

9.02 Contractor further agrees to include in subcontract(s), if any, a provision that any subcontractor agrees that City shall have access to and the right to examine any directly pertinent books, documents, papers and records of such subcontractor involving transactions to the subcontract, and further, that City shall have access during normal working hours to all subcontractor facilities, and shall be provided adequate and appropriate work space, in order to conduct audits in compliance with the provisions of this paragraph.

ARTICLE 10 – PROHIBITION ON CONTRACTS WITH CERTAIN COMPANIES

10.01 Texas Government Code Chapter 2270 applies to the award of government contracts to companies that boycott Israel. Section 2270.02 states that a "governmental entity may not enter into a contract with a company for goods or services unless the contract contains a written verification from the company that it: (1) does not boycott Israel; and (2) will not boycott Israel during the term of the contract." Contractor is to certify that it does not boycott Israel and will not boycott Israel during the term of this Contract by submitting the form in Section 00 45 04 "Verification Relating to Boycotting Israel."

10.02 Texas Government Code Chapter 2252, Subchapter F of the Texas Government Code prohibits any municipal government from entering into a contract for goods and services with companies that engage in business with Iran, Sudan, or foreign terrorist organizations. Contractor is to certify that it does not engage in business with Iran, Sudan, or foreign terrorist organizations and will not engage in business with Iran, Sudan, or foreign terrorist organizations during the term of the Contract by submitting the form in Section 00 45 05 "Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations."

ARTICLE 11 – VENUE

11.01 Contractor agrees that venue lies exclusively in Tarrant County, Texas for any legal action.

ARTICLE 12 – CONTRACT DOCUMENTS

12.01 Contract Documents:

A. Specifications Sections listed in Section 00 01 10 "Table of Contents" except as specifically excluded in Paragraph 12.02.

B. Drawings listed in the Drawings. Section 00 01 15 "List of Drawings."

C. Addenda (Numbers 00 91 01 to 00 91 **[XX]**, inclusive).

D. Appendices listed in Section 00 01 10 "Table of Contents" except as specifically excluded in Paragraph 12.02.

E. The following are also Contract Documents which may be delivered or issued on or after the Effective Date of the Contract:

1. Notice to Proceed.

2. Contract Amendment(s).
3. Change Order(s).
4. Field Order(s).
5. Work Change Directive(s).

F. There are no Contract Documents other than those listed above in this Paragraph. The Contract Documents may only be amended, modified, or supplemented as provided in `the General Conditions.

12.02 Bidding Requirements and Informational Documents:

A. The following Bidding Requirements are not Contract Documents but are considered Contracting Information under Texas Government Code Chapter 552:

1. Invitation to Bid.
2. Section 00 21 13 “Instructions to Bidders.”
3. Section 00 41 13 “Bid Form.”
4. Section 00 43 16 “Bid Form Exhibit A”
5. Section 00 43 13 “Bid Bond.”
6. Section 00 45 01 “Contractor Residency Statement.”
7. Section 00 45 03 “Conflict of Interest Questionnaire.”
8. Section 00 45 07 “Compliance to State Sales Tax Code.”

B. The following documents are provided for information only and are not part of the Contract Documents but are considered Contracting Information under Texas Government Code Chapter 552:

1. Documents listed in Section 00 73 00 “Supplementary Conditions” Paragraph SC-5.03 Paragraph B.

ARTICLE 13 – CONTRACTOR’S REPRESENTATIONS

13.01 The 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 is familiar with Laws and Regulations that may affect cost, progress, and performance of the Work.

C. Contractor has carefully studied the following Site related reports and drawings as identified in the Supplementary Conditions:

1. Geotechnical Data Reports regarding subsurface conditions at or adjacent to the Site;
2. Drawings of physical conditions relating to existing surface or subsurface structures at the Site;
3. Underground Facilities referenced in reports and drawings;

4. Reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site; and

5. Technical Data related to each of these reports and drawings.

D. Contractor has considered the:

1. Information known to Contractor;

2. Information commonly known to contractors doing business in the locality of the Site;

3. The Contract Documents.

E. Contractor has considered the items identified in Paragraphs 8.01.D and 8.01.E 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; and

3. Contractor's safety precautions and programs.

F. Based on the information and observations referred to in the preceding paragraphs, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract 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 correlated the information known to the Contractor, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

I. Contractor has given the Construction Manager written notice of all conflicts, errors, ambiguities, or discrepancies that the Contractor has discovered in the Contract Documents, and the written resolution provided by the Construction Manager is acceptable to the Contractor.

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

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

L. Contractor is not ineligible to be awarded this Contract under Texas Government Code Section 2155.004.

M. Contractor is not ineligible to be awarded this Contract under Texas Government Code Chapter 2252, Subchapter F.

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

IN WITNESS WHEREOF, the parties of these presents have executed this agreement:

Contractor

_____
Company Name

_____
Tax Identification Number

_____
Signature

_____
Printed or Typed Name

_____
Printed or Typed Title

City of Arlington, Texas

_____
Director

Attest

_____
Alex Busken, City Secretary

Approved as to Form

_____
Teris Solis, City Attorney

_____
Signature

STATE OF TEXAS

COUNTY OF TARRANT

Contractor Acknowledgement

BEFORE ME, the undersigned authority, a Notary Public in and for the State of Texas, on this day personally appeared _____,

☐ who is known to me;

☐ who was proved to me on the oath of _____ (name of person identifying the acknowledging person); or

☐ who was proved to me through _____ (description of identity card or other document issued by the federal or state government containing the picture and signature of the acknowledging person) to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he/she executed same for and as the act and deed of _____, a corporation of _____ County, Texas, and as _____ thereof, and for the purposes and consideration therein expressed and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the _____ day of _____ , 20___.

_____

Notary Public in and for the State of Texas

_____

Notary's Printed Name

City Acknowledgement

BEFORE ME, the undersigned authority, a Notary Public in and for the State of Texas, on this day personally appeared Craig M. Cummings, known to me to be a person and officer whose name is subscribed to the foregoing instrument, and acknowledged to me that he/she executed same for and as the act of the City of Arlington, Texas, a Texas municipal corporation, and as Director of Water Utilities thereof, and for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the _____ day of _____ , 20___.

_____

Notary Public in and for the State of Texas

_____

Notary's Printed Name

END OF SECTION

00 52 16 Agreement Exhibit A

[Form to be modified and completed when Contract is conformed for execution]

Project:			**Project No.:**
Owner:	City of Arlington, Texas		
Engineer:			
Offeror:			

Base Bid

Item No.	Item Description	Unit	Estimated Quantity	Unit Price	Extended Amount
Items in Base Contract per Section 01 29 01 "Measurement and Basis for Payment"					
A-01					
A-02					
A-03					
A-04					
A-05					
A-06					
A-07					
A-08					
A-09					
A-10					
A	**Total Base Contract Items Amount (Sum of Extended Amounts for each Contract Line Item)**				
Allowances in Base Contract per Section 01 23 10 "Alternates and Allowances"					
B-01					
B-02					
B-03					
B-04					
B-05					
B	**Total Allowance Amount (Sum of Extended Amounts for Each Allowance Line Item)**				
C	**Total Base Contract with Allowances (Sum of A and B)**				
Extra Work in Base Contract per Section 01 29 01 "Measurement and Basis for Payment"					
D-01					
D-02					
D-03					
D-04					
D-05					
D	**Total Extra Work Amount (Sum of Extended Amounts for Each Extra Work Line Item)**				
E	**Total Base Contract with Allowances and Extra Work Items (Sum of C and D)**				
Alternates included in the Contract per Section 01 23 10 "Alternates and Allowances"					
F-01					
F-02					
F-03					
F	**Total Amount for Accepted Alternates (Sum of Extended Amounts for Each Alternate Line Item)**				
G	**Total Base Contract with Allowance and Accepted Alternates (Sum of E and F)**				

Contract Time

H	Contractor agrees to reach Substantial Completion in		days
I	Contractor agrees to reach Final Completion in		days

Contractor: _____

Signature: _____

Printed Name: _____

Title: _____

Date: _____

00 61 13 PERFORMANCE BOND

STATE OF TEXAS

COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____

of the City of _____, County of _____

State of _____ hereinafter referred to as "PRINCIPAL," and

_____, a corporate

surety/sureties organized under the laws of the State of _____ and authorized to do business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County, Texas, hereinafter referred to as "CITY," in the amount of _____ DOLLARS ($_____), lawful money of the United States, to be paid in Arlington, Tarrant County, Texas, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, assigns, administrators and successors, jointly and severally; and firmly by these presents, the condition of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the ____ day of _____, 20____, a copy of which is attached hereto and made a part hereof, to furnish all materials, equipment, labor, supervision, and other accessories necessary for the construction of:

John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
City of Arlington Project No. WUTR19020

in the City of Arlington, Texas, as more particularly described and designated in the above referenced contract such contract being incorporated herein and made a part hereof as fully and to the same extent as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL shall well, truly and faithfully perform and fulfill all of the undertakings, covenants, terms, conditions and agreements of the above referenced Contract in accordance with the plans, specifications and Contract documents during the original term thereof, and any extension thereof which may be granted with or without notice to SURETY, and during the life of any guaranty required under the Contract, and shall also well and truly perform and fulfill all the covenants, terms, conditions and agreements of any and all authorized modifications of such Contract that may hereafter be made, notice of which modifications to SURETY being hereby waived, then this obligation shall be void, otherwise to remain in full force and effect; and in case PRINCIPAL shall fail to do so, it is agreed that CITY may do such work and supply such materials and charge the same against PRINCIPAL and SURETY on this obligation, and PRINCIPAL and SURETY hereon shall be subject to the liquidated damages

mentioned in the Contract for each day's failure on its part to comply with the terms and provisions of such Contract.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that SURETY, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans, specifications, drawings, etc., accompanying same shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by SURETY as the agent resident in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20___.

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

PRINCIPAL

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

SURETY

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

NOTE: Date of Performance Bond must NOT be prior to date of Contract

END OF SECTION

00 61 16 PAYMENT BOND

STATE OF TEXAS

COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____

of the City of _____, County of _____

State of _____ hereinafter referred to as "PRINCIPAL," and

_____, a corporate surety/sureties organized under the laws of the State of _____ and authorized to do business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County, Texas, hereinafter referred to as "CITY," and unto all persons, firms and corporations who may furnish materials for or perform labor upon the buildings, structures or improvements referred to in the attached Contract, in the penal sum of _____DOLLARS ($_____), lawful money of the United States, to be paid in Arlington, Tarrant County, Texas, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally; and firmly by these presents, the condition of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the _____ day of _____, 20_____, a copy of which is attached hereto and made a part hereof, to furnish all materials, equipment, labor, supervision, and other accessories necessary for the construction of:

John F. Kubala WTP West High Service Pump Station Pump 4 & 5 Additions
City of Arlington Project No. WUTR19020

in the City of Arlington, Texas, as more particularly described and designated in the above referenced contract such contract being incorporated herein and made a part hereof as fully and to the same extent as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL shall well, truly and faithfully perform its duties and make prompt payment to all persons, firms, subcontractors, corporations and claimants supplying labor and materials in the prosecution of the work provided for in the above referenced Contract and any and all duly authorized modifications of such Contract that may hereafter be made, notice to SURETY of such modifications being hereby waived, then this obligation shall be void, otherwise to remain in full force and effect.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that such SURETY, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans, specifications, drawings, etc. accompanying same shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder.

This Bond is given pursuant to the provisions of Chapter 2253 of the Government Code, as amended. The terms "payment bond beneficiary", "public work labor", and "public work material", as used herein, are in accordance with and as defined in the relevant provisions of Chapter 2253 of the Government Code.

The undersigned and designated agent is hereby designated by SURETY as the resident agent in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20____.

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

PRINCIPAL

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

SURETY

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

The Resident Agent of the SURETY in either Tarrant or Dallas County, Texas, for delivery of notice and service of process is:

Name _____

Address _____

NOTE: Date of Payment Bond must NOT be prior to date of Contract

END OF SECTION

00 61 19 MAINTENANCE BOND

STATE OF TEXAS
COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____
of the City of _____, County of _____
State of _____ hereinafter referred to as "PRINCIPAL," and
_____, a corporate surety/sureties organized under the laws of the State of _____ and authorized to do business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County, Texas, hereinafter referred to as "CITY," in the amount of **[[50] percent of the Contract Price] [$ Insert Bond Amount]**, lawful money of the United States, to be paid in Arlington, Tarrant County, Texas, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, assigns, administrators and successors, jointly and severally; and firmly by these presents, the condition of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the ____ day of _____, 20____, a copy of which is attached hereto and made a part hereof, to furnish all materials, equipment, labor, supervision, and other accessories necessary for the construction of:

[Project Name]
City of Arlington Project No. [Project Number]

in the City of Arlington, Texas, as more particularly described and designated in the above referenced contract such contract being incorporated herein and made a part hereof as fully and to the same extent as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL will maintain and keep in good repair the work herein contracted to be done and performed for a period beginning 364 days after Substantial Completion and continuing for a period of **[one (1)] [two (2)]** year**[s]** and perform all necessary work and repair any defective condition growing out of or arising in any part of the construction of said improvement then this obligation shall be void, otherwise it shall remain in full force and effect. It being understood that the purpose of this section is to cover all defective conditions arising by reason of defective materials, work or labor performed by PRINCIPAL. In case PRINCIPAL shall fail to do so, it is agreed that CITY may do such work and supply such materials and charge the same against PRINCIPAL and SURETY on this obligation.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that SURETY, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans, specifications, drawings, etc., accompanying same shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by SURETY as the agent resident in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20___.

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

PRINCIPAL

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

WITNESS

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

SURETY

_____
Company

By: _____
Signature

_____
Typed / Printed Name

_____
Title

_____
Address

_____
City, State, Zip

NOTE: Date of Maintenance Bond must NOT be prior to date of Contract

MAINTENANCE BOND REQUIREMENTS

1. A maintenance bond is defined as a performance bond that extends the correction period for a specified period beyond the one-year correction period described in the General Conditions.
2. The maintenance bond must meet the same requirements for bonds as the Contractor's performance bond described in the Contract Documents.
3. Surety for the maintenance bond must be the same surety that provides performance and payment bonds as set forth in the General Conditions.
4. Indemnification provisions of the General Conditions apply to the maintenance bond period.
5. Correct Defective Work during the one-year correction period in accordance with the General Conditions.
6. Correct Defective Work during the maintenance bond period just as required for the one-year correction period specified in the General Conditions. Provide labor and materials required to correct Defective Work or correct Work that does not function as required by the Contract Documents.
7. Correction of Defective Work during the maintenance bond period does not extend the correction period as is required under the provisions of the one-year correction period described in the General Conditions.
8. Promptly correct damages to the Site or adjacent areas that Contractor has arranged to use through construction easements or other agreements. Promptly correct damages to the Work or the work of others. Make the corrections without cost to Owner.
9. Owner may correct Defective Work without notice to the Contractor in an emergency where delay would cause serious risk of loss or damage.
10. Include the cost for correcting Defective Work during the maintenance bond period in the Contract Price. Include all costs associated with providing the maintenance bond in the Contract Price.
11. Reimburse the Owner for engineering and special services required to be furnished by the Owner which are directly attributable to the corrective Work.
12. Remedy for Failure to Correct Defective Work:
    a. Owner may correct Defective Work if the Contractor fails or refuses to perform corrective Work within 10 days after Owner notifies the Contractor of Defective Work.
    b. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this paragraph are to be paid by the Contractor or its surety. These claims, costs, losses, and damages include costs of repair and the cost of replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's Defective Work. Owner is not required to obtain the lowest price for the Work performed when exercising its rights or remedies under this paragraph.
13. Provide insurance as required by the Contract Documents during the maintenance bond period. Provide evidence of insurance prior to beginning corrective Work if evidence of insurance is not current.

END OF SECTION

00 72 00 GENERAL CONDITIONS

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

A. A term with initial capital letters, including the term's singular and plural forms, has the meaning indicated in this paragraph wherever used in the Bidding Requirements or Proposal Requirements or the Contract Documents. In addition to the terms specifically defined, terms with initial capital letters in the Contract Documents may include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Documents issued prior to the receipt of Bids or Proposals which clarify or modify the Bidding Requirements, Proposal Requirements, or the proposed Contract Documents.

2. *Agreement*—The document signed by Owner and Contractor that establishes the Contract Price and Contract Times and designates the specific documents that are Contract Documents.

3. *Application for Payment*—The documents used by Contractor to request payments from Owner and the supporting documentation required by the Contract Documents.

4. *Bid; Proposal*—An offer submitted to the Owner for the Project setting forth the Contract Price and Contract Times for the Work to be performed.

5. *Bidding Documents; Proposal Documents*—The Bidding Requirements or Proposal Requirements, the proposed Contract Documents, and Addenda.

6. *Bidding Requirements; Proposal Requirements*—The Invitation to Bid or Request for Proposals, Instructions to Offerors, Bid Security or Proposal Security, Bid Form or Proposal Form and attachments, and required certifications and affidavits.

7. *Bid Security; Proposal Security*—The financial security provided by Offeror at the time the Bid or Proposal is submitted and held by Owner until the Agreement is executed and the evidence of insurance and bonds required by the Contract Documents are provided.

8. *Change Order*—A document issued on or after the Effective Date of the Contract and signed by Owner and Contractor which modifies the Work, Contract Price, Contract Times, or terms and conditions of the Contract.

9. *Change Proposal*—A document submitted by Contractor in accordance with the requirements of the Contract Documents:

    a. Requesting an adjustment in Contract Price or Contract Times;

    b. Contesting an initial decision concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents;

    c. Challenging a set-off against payment due; or

    d. Seeking other relief with respect to the terms and conditions of the Contract.

10. *Claim*—A demand or assertion by Owner or Contractor submitted in accordance with the requirements of the Contract Documents. A demand for money or services by an entity other than the Owner or Contractor is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning any hazardous, toxic, or dangerous waste, substance, or material.

12. *Construction Manager*—The individual or entity named as the Construction Manager in the Agreement and the consultants, subconsultants, individuals, or entities directly or indirectly employed or retained by them to provide construction management as advisor services to the Owner.

13. *Contract*—The entire integrated set of documents concerning the Work and describing the relationship between the Owner and Contractor.

14. *Contract Amendment*—A document issued on or after the Effective Date of the Contract and signed by Owner and Contractor which:

    a. Authorizes new phases of the Work and establishes the Contract Price, Contract Times, or terms and conditions of the Contract for the new phase of Work; or

    b. Modifies the terms and conditions of the Contract but does not make changes in the Work.

15. *Contract Documents*—Those items designated as Contract Documents in the Agreement.

16. *Contract Price*—The monetary amount stated in the Agreement and as adjusted by Modifications, and increases or decreases in unit price quantities, if any, that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

17. *Contract Times*—The number of days or the dates by which Contractor must achieve specified Milestones, achieve Substantial Completion, and complete the Work.

18. *Contractor*—The individual or entity with which Owner has contracted to perform the Work.

19. *Contractor's Team*—Contractor, Subcontractors, Suppliers, and individuals or entities directly or indirectly employed or retained by Contractor, Subcontractors, or Suppliers to perform part of the Work, or anyone for whose acts they may be liable.

20. *Cost of the Work*—The sum of costs incurred for the performance of the Work as allowed by Article 13.

21. *Day*—A day of 24 hours measured from midnight to the next midnight.

22. *Defective*—When applied to Work, refers to Work that is unsatisfactory, faulty, or deficient in that it:

    a. Does not conform to the Contract Documents;

    b. Does not meet the requirements of applicable inspections, reference standards, tests, or approvals referred to in the Contract Documents; or

    c. Has been damaged prior to Construction Manager's recommendation of final payment unless responsibility for the protection of the Work has been assumed

by Owner at Substantial Completion in accordance with Paragraphs 15.03 or 15.04.

23. *Design Professional*—The individuals or entity named as the Architect or Engineer in the Agreement and the subconsultants, individuals, or entities directly or indirectly employed or retained by Design Professional to provide design or other technical services to the Owner. Design Professional has responsibility for design and technical issues related to the Contract Documents.

24. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work. Shop Drawings and other documents generated by Contractor's Team are not Drawings.

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

26. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including Shop Drawings and other Submittals, that are in an electronic or digital format.

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

28. *Engineer's Estimate*—The amount budgeted by the Owner for the construction of the Project.

29. *Field Order*—A document issued by Construction Manager or Design Professional requiring changes in the Work that do not change the Contract Price or the Contract Times.

30. *Final Completion*—The point where the Work is complete in accordance with the Contract Documents, items and documents required by the Contract Documents have been accepted by the Owner, and the Project is ready for Final Payment.

31. *Hazardous Environmental Condition*—The presence of Constituents of Concern at the Site in quantities or circumstances that may present a danger to persons or property exposed to Constituents of Concern. The presence of Constituents of Concern at the Site necessary for the execution of the Work or to be incorporated into the Work is not a Hazardous Environmental Condition provided these Constituents of Concern are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract.

    a. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.

b. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

32. *Indemnified Costs*—All costs, losses, judgments, and damages resulting from claims or demands against Owner's Indemnitees. These costs include fees for design professionals, attorneys, and other professionals and any legal, court, arbitration, or other dispute resolution costs.

33. *Laws and Regulations; Laws or Regulations*—Applicable laws, statutes, rules, regulations, ordinances, codes, permits, and binding decrees, resolutions, and orders of governmental bodies, agencies, authorities, and courts having jurisdiction over the Project.

34. *Liens*—Charges, security interests, or encumbrances upon Contract related funds, real property, or private property.

35. *Manufacturer*—The individual or entity that designs, casts, fabricates, manufactures, assembles, tests, and provides materials or equipment to be incorporated in the Work.

36. *Milestone*—A principal event in the performance of the Work that Contractor is required by Contract to complete by a specified date or within a specified time.

37. *Modification*—Change made to the Contract Documents by Contract Amendment, Change Order, Field Order, or Work Change Directive.

38. *Notice of Award*—The notice of Owner's acceptance of the Successful Offeror's Bid or Proposal.

39. *Notice to Proceed*—A notice to Contractor of the Contract Times and the date Work is to begin.

40. *Offeror*—An individual or entity that submits a Bid or Proposal to Owner.

41. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

42. *Owner's Indemnitees*—Each member of the OPT and their officers, directors, members, partners, employees, agents, consultants, and subcontractors.

43. *Owner's Project Team (OPT)*—The Owner, Design Professional, Construction Manager, and the other entities identified in the Supplementary Conditions and the consultants, subconsultants, individuals or entities directly or indirectly employed or retained by them to provide services to the Owner.

44. *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.

45. *Project*—The total undertaking to be accomplished for Owner under the Contract Documents.

46. *Project Construction Manager (PCM)*—The authorized representative of the OPT assigned to assist the Construction Manager at the Site. The term Project Construction Manager includes assistants and field staff of the Construction Manager.

47. *Project Management Information System (PMIS)*—The online project management system that will be used by OPT and Contractor to submit and share documentation and other related communications and information for this Project.

48. *Samples*—Physical examples of materials, equipment, or workmanship representing some portion of the Work that are used to establish the standards for that portion of the Work.

49. *Schedule of Anticipated Payments*—A detailed tabulation, prepared and maintained by Contractor, showing the anticipated amount of each Application for Payment and the month in which they will be submitted.

50. *Schedule of Documents*—A detailed tabulation, prepared and maintained by Contractor, of each required document submittal and the time requirements for review and approval of each submittal.

51. *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 Contractor's Applications for Payment.

52. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by Contractor's Team and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

53. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed. The Site includes rights-of-way, easements, and other lands or areas furnished by Owner which are designated for use by the Contractor.

54. *Specifications*—The part of the Contract that describes the requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

55. *Subcontractor*—An individual or entity having a direct contract with Contractor or with other Subcontractors or Suppliers for the performance of a part of the Work.

56. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Construction Manager, or that is indicated as a Submittal in the Schedule of Documents accepted by Construction Manager. Submittals, whether approved or accepted by OPT, are not Contract Documents.

57. *Substantial Completion*—The point where the Work or a specified part of the Work is sufficiently complete to be used for its intended purpose in accordance with the Contract Documents.

58. *Successful Offeror*—The Offeror to which Owner awards the Contract.

59. *Supplementary Conditions*—The part of the Contract that amends or supplements the General Conditions.

60. *Supplier*—A Manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with Subcontractors or other Suppliers to furnish materials or equipment to be incorporated in the Work.

61. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions with respect to either:

    a. Existing subsurface conditions at or adjacent to the Site;

    b. Existing physical conditions at or adjacent to the Site including existing surface or subsurface structures at the Site, except Underground Facilities; or

    c. Hazardous Environmental Conditions at the Site.

62. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site , including those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.

63. *Unit Price Work*—Work to be paid for based on unit prices.

64. *Work*—The construction of the Project or its component parts as required by the Contract Documents.

65. *Work Change Directive*—A directive issued to Contractor on or after the Effective Date of the Contract ordering an addition, deletion, or revision in the Work. The Work Change Directive serves as a memorandum of understanding regarding the directive until a Change Order can be issued.

1.02 Terminology

A. The words and terms discussed in this Paragraph 1.02 are not defined terms that require initial capital letters, but when used in the Bidding Requirements or Proposal Requirements, or the Contract Documents, have the indicated meaning.

B. Contract Documents are written using imperative language:

    1. Simple imperative sentence structure is used which places a verb as the first word in the sentence. It is understood that the words “furnish,” “install,” “perform,” “provide,” or similar words include the meaning of the phrase “The Contractor shall...” before these words.

    2. Unless specifically stated that action is to be taken by the OPT or others, it is understood that the action described is a requirement of the Contractor.

C. The use of the words “furnish,” “install,” “perform,” and “provide” have the following meanings when used relating to services, materials, or equipment:

    1. Furnish means to supply and deliver the specified services, materials, or equipment to the Site or other specified location ready for use or installation.

    2. Install means to complete construction or assembly of the specified services, materials, or equipment so they are ready for their intended use.

    3. Perform or provide means to furnish and install specified services, materials, or equipment, complete and ready for their intended use.

4. Perform or provide the specified services, materials, or equipment complete and ready for intended use if the Contract Documents require specific services, materials, or equipment, but do not expressly use the words “furnish,” “install,” “perform,” or “provide.”

D. The meaning and intent of certain terms or adjectives are described as follows:

1. The terms “as allowed,” “as approved,” “as ordered,” “as directed,” or similar terms in the Contract Documents indicate an exercise of professional judgment by the OPT.

2. Adjectives like “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or similar adjectives are used to describe a determination of OPT regarding the Work.

3. Any exercise of professional judgment by the OPT will be made solely to evaluate the Work for general compliance with the Contract Documents unless there is a specific statement in the Contract Documents indicating otherwise.

4. The use of these or similar terms or adjectives does not assign a duty or give OPT authority to supervise or direct the performance of the Work, or assign a duty or give authority to the OPT to undertake responsibilities contrary to the provisions of Article 9, Article 10, or other provisions of the Contract Documents.

E. Requirements apply to all Work of the same kind, class, and type even though the word “all” or “any” is not stated.

F. The terms "includes" and “including" are used as terms of enlargement and not of limitation or exclusive enumeration, and use of these terms does not create a presumption that components not expressed are excluded. The terms “consist of” or “consisting of” limits the interpretation to only those items specifically listed.

G. It is understood that the cost of providing Work is included in the Contract Price and no additional compensation is to be paid by Owner unless specifically stated otherwise in the Contract Documents. Expressions like “at no additional cost to Owner,” “at Contractor’s expense,” or similar words mean that the Contractor is to include the cost of this Work in their Contract Price and perform or provide specified Work without an increase in the Contract Price.

H. Words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with this recognized meaning unless stated otherwise in the Contract Documents.

I. Written documents are required where reference is made to notices, reports, approvals, consents, statements, instructions, opinions, or other types of documentation or communications required by the Contract Documents. Approval and consent documents must be received by Contractor prior to the action or decision for which approval or consent is given. These may be made in printed or electronic format through the OPT’s Project Management Information System or other electronic media as required by the Contract Documents or approved by the Construction Manager.

J. Giving notice as required by the Contract Documents may be by printed or electronic media using a method that requires acknowledgment of the receipt of that notice.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

A. Provide required bonds and evidence of insurance required by the Contract Documents to Construction Manager with the executed Agreement.

2.02 Copies of Documents

A. OPT will furnish one copy of the executed Contract Documents in electronic portable document format (PDF). This document is the Project Record Copy of the Contract Documents.

2.03 Before Starting Construction

A. Provide the following preliminary documents in accordance with the Contract Documents within 10 days after the Effective Date of the Contract:

1. Progress Schedule;
2. Schedule of Documents;
3. Schedule of Values; and
4. Schedule of Anticipated Payments.

B. Designate the specific individuals authorized to act as representatives of the Contractor. These individuals must have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of the Contractor.

C. Owner will designate the specific individuals authorized to act as representatives of the Owner and the limits of their authority regarding acting on behalf of the Owner.

2.04 Electronic Transmittals

A. Except as otherwise stated elsewhere in the Contract Documents, the OPT and Contractor will send and accept Electronic Documents sent by Electronic Means using protocols provided by or acceptable to the OPT.

B. The contents of the information in any Electronic Document will be the responsibility of the transmitting party. Electronic Documents may be used in the same manner as the printed versions of the same documents that are exchanged using non-electronic format and methods, and are subject to the same governing requirements, limitations, and restrictions, set forth in the Contract Documents.

C. Provisions of this Contract regarding Electronic Documents must be incorporated into other agreements or subcontracts on the Project. Nothing in this paragraph reduces or eliminates requirements:

1. to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations;
2. to comply with any applicable Law or Regulation governing the signing and sealing of design documents and related Modifications or the signing and electronic transmission of any other documents; or

3. to comply with the notice requirements.

D. When sending Electronic Documents by Electronic Means the sending party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or sending Electronic Documents.

E. System Infrastructure for Electronic Document Exchange (EDP):

1. Contractor will provide hardware, operating system(s) software, internet, e-mail, and large file transfer functions ("System Infrastructure") at its own cost. System Infrastructure must comply with these requirements.

2. The maximum size of an email attachment for exchange of Electronic Documents under this EDP is 100 MB. Attachments larger than that may be exchanged in parts or by using large file transfer functions or physical media.

3. Contractor assumes full and complete responsibility for its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, or otherwise enabling its System Infrastructure, including operating systems and software.

4. Contractor is responsible for its own system operations, security, back-up, archiving, audits, printing resources, and other Information Technology ("IT") for maintaining operations of its System Infrastructure during the Project, including coordination with individual(s) or entity responsible for managing its System Infrastructure and capable of addressing routine communications and other IT issues affecting the exchange of Electronic Documents.

5. Contractor will operate and maintain industry-standard, industry-accepted, ISO standard, commercial-grade security software and systems that are intended to protect others from: software viruses and other malicious software like worms, trojans, adware; data breaches; loss of confidentiality; and other threats in the transmission to or storage of information from the other parties, including transmission of Electronic Documents by physical media such as CD/DVD/flash drive/hard drive. Contractor will not be liable to others for any breach of system security to the extent that Contractor maintains and operates required security software and systems.

6. In the case of disputes, conflicts, or modifications to the use of Electronic Documents required to address issues affecting System Infrastructure, Contractor and OPT will cooperatively resolve the issues; but, failing resolution, the OPT is authorized to make and require reasonable and necessary changes meet its original intent. Contractor may submit a Change Proposal if the changes cause additional cost or time to Contractor that could not have reasonably been anticipated.

7. Contractor and OPT are both responsible for their own back-up and archive of documents sent and received during the term of the contract. Contractor and OPT remain solely responsible for its own post-Project back-up and archive of Project documents after the term of the Contract as each party deems necessary for its own purposes.

8. If a Contractor or OPT receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving party will advise the sending party of the incomplete transmission. The parties will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the communication.

9. The OPT will operate a project information management system (Project Website) for use of OPT and Contractor during the Project for exchange and storage of Project-related communications and information. Except as otherwise provided in this Contract, use of the Project Website will be mandatory for exchange of Project documents, communications, submittals, and other Project-related information.

F. Software Security: The parties agree not to intentionally edit, reverse engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes any Electronic Document or information contained therein that was transmitted in a software data format, including Portable Document Format (PDF), intended by sender not to be modified, unless the receiving party obtains the permission of the sending party or is citing or quoting excerpts of the Electronic Document for Project purposes.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 Intent

A. Requirements of each part of the Contract Documents are as binding as if required by all Contract Documents. It is the intent of the Contract Documents to describe a functionally complete project. The Contract Documents do not indicate or describe all the Work required to complete the Project. Additional details required for construction of the Project are to be provided by the Contractor and coordinated with the OPT.

B. Provide the labor, documentation, services, materials, or equipment that may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result, whether specifically called for in the Contract Documents or not. Include these related costs in the offered Contract Price.

C. Provide equipment that is functionally complete as described in the Contract Documents. The Drawings and Specifications do not indicate or describe all the Work required to complete the installation of equipment purchased by the Owner or Contractor. Additional details required for the correct installation of selected equipment are to be provided by the Contractor and coordinated with the Design Professional through the Construction Manager.

D. Comply with the most stringent requirements where compliance with two or more standards is specified and they establish different or conflicting requirements for the Work, unless the Contract Documents indicate otherwise.

E. Provide materials and equipment comparable in quality to similar materials and equipment incorporated in the Project or as required to meet the minimum requirements of the application if the materials and equipment are shown in the Drawings but are not included in the Specifications.

F. The Project Record Copy of the Contract Documents governs if there is a discrepancy between the Project Record Copy of the Contract Documents and subsequent electronic or

digital versions of the Contract Documents, including printed copies derived from these electronic or digital versions.

G. The Contract supersedes all prior written or oral negotiations, representations, and agreements. The Contract Documents comprise the entire Agreement between Owner and Contractor. The Contract Documents may be modified only by a Modification.

H. Request clarification from Construction Manager for a decision before proceeding if Contractor is not clear on the meaning of the Contract Documents. Construction Manager is to issue clarifications and interpretations of the Contract Documents in accordance with the Contract Documents.

I. Organization of the Documents:

1. Organization of the Contract Documents is not intended to control or lessen the responsibility of the Contractor when dividing Work among Subcontractors or Suppliers, or to establish the extent of Work to be performed by trades, Subcontractors, or Suppliers, except on multi-prime contracts. Specifications or details do not need to be indicated or specified in each Specification or Drawing. Items shown in the Contract Documents are applicable regardless of their location in the Contract Documents.

2. Standard paragraph titles and other identifications of subject matter in the Specifications are intended to aid in locating and recognizing various requirements of the Specifications. Titles do not define, limit, or otherwise restrict Specification text.

3. The Contract requirements described in the General Conditions, Supplementary Conditions, and General Requirements (Division 01 Sections of the Specifications) apply to Work regardless of where it is described in the Contract Documents, unless specifically noted otherwise.

4. Specifications or details do not need to be indicated or specified in each Specification or Drawing. Items shown in the Contract Documents are applicable regardless of their location in the Contract Documents.

J. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

K. Nothing in the Contract Documents creates:

1. a contractual relationship between OPT and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or

2. an obligation on the part of OPT to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 Reference Standards

A. Standard Specifications, Codes, Laws and Regulations:

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of technical societies, organizations, or associations, or to Laws or Regulations, whether specific or implied, are those in effect at the time Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price unless specifically stated otherwise in the Contract Documents.

2. No provision of referenced standard specifications, manuals, reference standards, codes, or instructions of a Supplier changes the duties or responsibilities of OPT or Contractor from those described in the Contract Documents or assigns a duty to or gives authority to the OPT to supervise or direct the performance of the Work or undertake responsibilities inconsistent with the Contract Documents.

3. The provisions of the Contract Documents take precedence over standard specifications, manuals, reference standards, codes, or instructions of a Supplier unless specifically stated otherwise in the Contract Documents.

B. Comply with applicable construction industry standards, whether referenced or not.

1. Standards referenced in the Contract Documents govern over standards not referenced but recognized as applicable in the construction industry.

2. Comply with the requirements of the Contract Documents if they produce a higher quality of Work than the applicable construction industry standards.

3. Submit questions regarding which code or standard is applicable to the Construction Manager. Design Professional will determine whether a code or standard is applicable, which of several codes or standards are applicable, or if the Contract Documents produce a higher quality of Work. Construction Manager will respond to the question as appropriate.

C. Make copies of reference standards available if requested by Construction Manager.

3.03 Reporting and Resolving Discrepancies

A. Reporting Discrepancies:

1. Carefully study the Drawings and verify pertinent figures and dimensions with respect to actual field measurements before undertaking the Work. Immediately report conflicts, errors, ambiguities, or discrepancies that Contractor discovers or has actual knowledge of to the Construction Manager.

2. Immediately notify the Construction Manager of conflicts, errors, ambiguities, or discrepancies in the Contract Documents or discrepancies between the Contract Documents and:

a. Applicable Laws or Regulations;

b. Actual field conditions;

c. Standard specifications, manuals, reference standards, or codes; or

d. Instructions of Suppliers.

3. Do not proceed with affected Work until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation from the Construction Manager or by a Modification to the Contract Documents issued pursuant to Paragraph 11.01, except in an emergency as required by Paragraph 7.12.

4. Contractor is liable to the OPT for failure to report conflicts, errors, ambiguities, or discrepancies in the Contract Documents of which Contractor has actual knowledge.

5. Contractor is deemed to have included the most expensive item, system, procedure, etc. in the Contract Price if a conflict, error, ambiguity, or discrepancy in the Contract Documents was known, but not reported prior to submitting the Bid or Proposal or when Contractor negotiates the Contract Price.

3.04 Interpretation of the Contract Documents

A. Submit questions concerning the non-technical or contractual/administrative requirements of the Contract Documents to the Construction Manager immediately after the question arises. Construction Manager will provide an interpretation of the Contract Documents regarding these questions and will coordinate the response of the OPT to Contractor.

B. Submit questions regarding the design of the Project described in the Contract Documents to the Construction Manager immediately after the question arises. Construction Manager will request an interpretation of the Contract Documents from the Design Professional. Construction Manager will coordinate the response of the OPT to Contractor.

C. OPT may initiate a Modification to the Contract Documents through the Construction Manager if a response to the question indicates that a change in the Contract Documents is required. Contractor may appeal Design Professional's or Construction Manager's interpretation by submitting a Change Proposal.

3.05 Reuse of Documents

A. Contractor's Team has no rights to the Contract Documents and may not use the Contract Documents or copies or electronic media editions of the Contract Documents other than for the construction of this Project. This provision survives final payment or termination of the Contract.

B. Contractor can retain a copy of the Contract Documents for record purposes, unless specifically prohibited by the Owner for security reasons. Surrender paper and digital copies of the Contract Documents and other related documents and remove these documents from computer equipment or storage devices as a condition of final payment if the Owner so directs.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 Commencement of Contract Times; Notice to Proceed

A. The Contract Times commence to run on the date indicated in the Notice to Proceed. If a Notice to Proceed is not issued, the Contract Times will commence to run 15 days after the Contract is signed by all parties.

B. Begin performing the Work on the date indicated in the Notice to Proceed. Do not begin Work before the date indicated in the Notice to Proceed or prior to providing evidence that insurance required by the Contract is in effect.

4.02 Progress Schedule

A. Construct the Work in accordance with the Progress Schedule established in accordance with the Contract Documents.

1. Adjust the Progress Schedule as required to accurately reflect actual progress on the Work.

2. Submit proposed adjustments in the Progress Schedule that change the Contract Times in accordance with the requirements of Article 11.

B. Continue performing Work and adhere to the Progress Schedule during disputes or disagreements with Owner. Do not delay or postpone Work pending resolution of disputes or disagreements, or during an appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree.

4.03 Delays in Contractor's Progress

A. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delays, disruptions, or interference caused by or within the control of Contractor's Team.

B. Contractor is entitled to an equitable adjustment in Contract Price or Contract Times if OPT directly delays, disrupts, or interferes with the performance or progress of the Work. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of the Owner if this delay is concurrent with a delay, disruption, or interference attributable to or within the control of the Contractor's Team.

C. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of OPT or Contractor. These adjustments in Contract Times are the Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. These unanticipated causes include:

1. Severe and unavoidable natural catastrophes e.g. fires, floods, epidemics, and earthquakes;

2. Acts of war or terrorism;

3. Acts or failures to act of utility owners or other third-party entities other than those third-party utility owners performing other work at or adjacent to the Site as arranged by the Owner and, as contemplated in Article 8;

4. The existence of a differing subsurface or physical condition;

5. An Underground Facility not shown or not indicated with reasonable accuracy by the Contract Documents;

6. Hazardous Environmental Conditions; and

7. Delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site unless this other work also for the Owner.

D. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed or disrupted by weather conditions provided such weather conditions exceed those that could normally be expected for the Site in that month of the year, unless other provisions for Weather related delays are included in the Contract Documents. Contractor is to include time associated with normal weather-related delays in the Project Schedule and assumes the risks, including costs, associated with delays related to normal weather conditions.

E. Contractor is only entitled to an adjustment of the Contract Times for specific delays, disruptions, and interference to the performance or progress of the Work that can be demonstrated to directly impact the ability of the Contractor to complete the Work within the Contract Times. No adjustments in Contract Times are allowed for delays on components of the Work which were or could have been completed without impacting the Contract Times.

F. Notify the Construction Manager immediately of a potential delaying, disrupting, or interfering event. Submit a Change Proposal seeking an adjustment in Contract Price or Contract Times within 30 days of the commencement of the delaying, disrupting, or interfering event. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11. Change Proposals seeking an increase in Contract Times or Contract Price submitted must include supporting data that details the following:

1. The circumstances that form the basis for the requested adjustment;
2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference;
5. A revised Progress Schedule indicating all the activities affected by the delay, disruption, or interference;
6. An explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work;
7. The impact on Contract Price, in accord with the provisions of Paragraph 11.07; and
8. Such additional supporting documentation as OPT may require.

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

5.01 Availability of Lands

A. Owner will furnish the Site and inform the Contractor of encumbrances or restrictions known to Owner related to use of the Site with which Contractor must comply in performing the Work.

B. Provide for additional lands and access Contractor requires for temporary construction facilities or storage of materials and equipment, other than those identified in the Contract Documents. Provide documentation of authority to use these additional lands to Construction Manager before using them.

5.02 Use of Site and Other Areas

A. Confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Owner or Contractor has arranged to use through construction easements or agreements, and other adjacent areas as permitted by Laws and Regulations. Assume full responsibility for damage or injuries which result from the performance of the Work or from other actions or conduct of the Contractor's Team, including:

1. Damage to the Site;

2. Damage to adjacent areas used for Contractor's Team's operations;

3. Damage to other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and

4. Injuries and losses sustained by the owners or occupants of these lands or areas.

B. Take the following action if a damage or injury claim is made by the owner or occupant of adjacent land or area because of the performance of the Work, or because of other actions or conduct of the Contractor's Team:

1. Take immediate corrective or remedial action as required by Paragraph 7.09; and

2. Attempt to settle the claim through negotiations with the owner or occupant, or otherwise resolve the claim by mediation or other dispute resolution proceeding or at law; and

3. **TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ANY SUCH CLAIM AND ALL INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO ANY CLAIM OR ACTION BROUGHT BY ANY SUCH OWNER OR OCCUPANT AGAINST OWNER'S INDEMNITEES TO THE EXTENT CAUSED DIRECTLY OR INDIRECTLY, IN WHOLE OR IN PART BY, OR BASED UPON, CONTRACTOR'S PERFORMANCE OF THE WORK, OR BECAUSE OF OTHER ACTIONS OR CONDUCT OF THE CONTRACTOR'S TEAM.**

5.03 Subsurface and Physical Conditions

A. The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data; and

2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site, except Underground Facilities, that contain Technical Data.

3. Technical Data contained in these reports and drawings.

B. If no Technical Data have been identified in the Supplementary Conditions, then Technical Data is defined, with respect to conditions at the Site, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, or environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.

C. Information and data regarding the presence or location of Underground Facilities is not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

D. Contractor may rely upon the accuracy of the Technical Data contained in these reports and drawings, but these reports and drawings are not Contract Documents. Except for this reliance on Technical Data, Contractor may not rely upon or make claims against Owner's Indemnitees with respect to:

1. The completeness of reports and drawings for Contractor's purposes, including aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, or Contractor's safety precautions and programs; or

2. Other data, interpretations, opinions, and information contained in these reports or shown or indicated in the drawings; or

3. The contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or

4. Contractor's interpretation of or conclusions drawn from Technical Data or other data, interpretations, opinions, or information.

5.04 Differing Subsurface or Physical Conditions

A. Notify Construction Manager immediately, but in no event later than 3 days, after becoming aware of a subsurface or physical condition that is uncovered or revealed at the Site, and before further disturbing the subsurface or physical conditions or performing any related Work that:

1. Establishes that the Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;

2. Requires a change in the Drawings or Specifications;

3. Differs materially from that shown or indicated in the Contract Documents; or

4. Is of an unusual nature and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents.

B. Do not further disturb or perform Work related to this subsurface or physical condition, except in an emergency as required by Paragraph 7.12, until permission to do so is issued by Construction Manager.

C. Construction Manager is to notify the OPT after receiving notice of a differing subsurface or physical condition from the Contractor. OPT will:

1. Promptly review the subsurface or physical condition;

2. Determine the necessity of OPT's obtaining additional exploration or tests with respect the subsurface or physical condition;

3. Determine if the subsurface or physical condition falls within one or more of the differing site condition categories in Paragraph 5.04.A;

4. Prepare recommendations regarding the Contractor's resumption of Work relating to the subsurface or physical condition in question;

5. Determine the need for changes in the Drawings or Specifications; and

6. Advise Contractor of OPT's findings, conclusions, and recommendations.

D. Construction Manager is to issue a statement to Contractor regarding the subsurface or physical condition in question and recommend action as appropriate after review of OPT's findings, conclusions, and recommendations. Construction Manager may instruct Contractor to resume Work if OPT determines that the subsurface or physical condition in question has been adequately documented.

E. Contractor is entitled to an equitable adjustment in Contract Price or Contract Times to the extent that a differing subsurface or physical condition causes a change in Contractor's cost or time to perform the Work provided the condition falls within one or more of the categories described in Paragraph 5.04.A. Any adjustment in Contract Price for Work that is paid for on a unit price basis is subject to the provisions of Paragraph 13.03. Contractor is not entitled to an adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

1. Contractor knew of the existence of the subsurface or physical condition at the time Contractor made an offer to Owner with respect to Contract Price and Contract Times;

2. The existence of the subsurface or physical condition could have been discovered or revealed by examinations, investigations, explorations, tests, or studies of the Site and contiguous areas expressly required by the Bidding Requirements or Proposal Requirements or the Contract Documents prior to when Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price; or

3. Contractor failed to give notice as required by Paragraph 5.04.A.

F. Contractor may submit a Change Proposal no later than 30 days after Construction Manager's issuance of the OPT's statement to Contractor regarding the subsurface or physical condition in question.

5.05 Underground Facilities

A. The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to OPT by the owners of these Underground Facilities or by others. OPT is not responsible for the accuracy or completeness of information or data provided by others that OPT makes available to Contractor. The Contractor is responsible for:

   1. Reviewing and checking available information and data regarding existing Underground Facilities at the Site;

   2. Complying with Laws and Regulations related to locating Underground Facilities before beginning Work;

   3. Locating Underground Facilities shown or indicated in the Contract Documents;

   4. Coordinating the Work with the owners, including Owner, of Underground Facilities during construction; and

   5. The safety and protection of existing Underground Facilities at or adjacent to the Site and repairing damage resulting from the Work.

B. Notify the Construction Manager and the owner of the Underground Facility immediately if an Underground Facility is uncovered or revealed at the Site that was not shown in the Contract Documents or was not shown with reasonable accuracy in the Contract Documents. Do not further disturb conditions or perform Work affected by this discovery, except in the event of an emergency as required by Paragraph 7.12.

C. The OPT is to take the following action after receiving notice from the Construction Manager:

   1. Promptly review the Underground Facility to determine if the Underground Facility was shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy;

   2. Identify and communicate with the owner of the Underground Facility;

   3. Prepare recommendations to OPT regarding the Contractor's resumption of Work relating to this Underground Facility;

   4. Determine the extent to which a change is required in the Drawings or Specifications to document the consequences of the existence or location of the Underground Facility; and

   5. Construction Manager will advise Contractor of OPT's findings, conclusions, and recommendations and provide revised Drawings and Specifications if required.

D. Construction Manager is to issue a statement to Contractor regarding the Underground Facility in question and recommend action as appropriate after review of OPT's findings, conclusions, and recommendations.

E. Contractor is entitled to an equitable adjustment in the Contract Price or Contract Times as provided in Paragraphs 11.04 and 11.05 to the extent that the existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy. Any adjustment in Contract Price for Work that is paid for on a unit price basis is subject to the provisions of Paragraph 13.03.

F. Contractor is not entitled an adjustment in the Contract Price or Contract Times with respect to an existing Underground Facility at the Site if:

1. Contractor knew of the existence of the existing Underground Facility at the Site at the time Contractor made an offer to Owner with respect to Contract Price and Contract Times;

2. The existence of the existing Underground Facility at the Site could have been discovered or revealed by examinations, investigations, explorations, tests, or studies of the Site and contiguous areas expressly required by the Bidding Requirements or Proposal Requirements or the Contract Documents prior to when Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price; or

3. Contractor failed to give notice as required by Paragraph 5.05.B.

G. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of adjustments in the Contract Price or Contract Times no later than 30 days after Construction Manager's issuance of OPT's statement to Contractor regarding the Underground Facility.

5.06 Hazardous Environmental Conditions at Site

A. The Supplementary Conditions identify those reports and drawings known to OPT relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and the Technical Data contained in these reports and drawings.

B. Contractor may rely upon the accuracy of the Technical Data contained in reports and drawings relating to Hazardous Environmental Conditions identified in the Supplementary Conditions, but these reports and drawings are not Contract Documents. Except for the reliance on expressly identified Technical Data, Contractor may not rely upon or make claims against Owner's Indemnitees with respect to:

1. The completeness of these reports and drawings for Contractor's purposes, including aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor or Contractor's safety precautions and programs related to Hazardous Environmental Conditions;

2. Other data, interpretations, opinions, and information contained in these reports or shown or indicated in the drawings; or

3. Any Contractor interpretation of or conclusion drawn from Technical Data or other data, interpretations, opinions, or information.

C. The results of tests performed on materials described in environmental reports specifically prepared for the Project and made available to Contractor are defined as Technical Data unless Technical Data has been defined more specifically in the Supplementary Conditions.

D. Contractor is not responsible for removing or remediating Hazardous Environmental Conditions encountered, uncovered, or revealed at the Site unless this removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

E. Contractor is responsible for controlling, containing, and duly removing and remediating Constituents of Concern brought to the Site by Contractor's Team and paying associated costs.

1. Owner may remove and remediate the Hazardous Environmental Condition and impose a set-off against payments to Contractor for associated costs if Contractor's Team creates a Hazardous Environmental Condition and Contractor does not take acceptable action to remove and remediate the Hazardous Environmental Condition.

2. **TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE FAILURE TO CONTROL, CONTAIN, OR REMOVE A CONSTITUENT OF CONCERN BROUGHT TO THE SITE BY CONTRACTOR'S TEAM, OR TO A HAZARDOUS ENVIRONMENTAL CONDITION CREATED BY CONTRACTOR'S TEAM. NOTHING IN THIS PARAGRAPH SHALL OBLIGATE CONTRACTOR TO INDEMNIFY ANY INDIVIDUAL OR ENTITY FROM AND AGAINST THE CONSEQUENCES OF THAT INDIVIDUAL'S OR ENTITY'S OWN NEGLIGENCE.**

F. Immediately notify the Construction Manager and take the following action if Contractor uncovers or reveals a Hazardous Environmental Condition at the Site or adjacent areas used by the Contractor's Team that was not created by the Contractor's Team:

1. Secure or otherwise isolate this condition;

2. Stop Work in affected areas or connected with the condition, except in an emergency as required by Paragraph 7.12; and

3. Do not resume Work relating to the Hazardous Environmental Condition or in affected areas until after OPT has obtained required permits and Construction Manager sends notice to the Contractor:

   a. Specifying that this condition and affected areas are or have been rendered safe for the resumption of Work; or

   b. Specifying special conditions under which Work may be resumed safely.

4. Owner may order the portion of the Work that is in the area affected by the Hazardous Environmental Condition to be deleted from the Work following the procedures in Article 11 if Contractor does not agree to:

   a. Resume the Work based on a reasonable belief it is unsafe; or

   b. Resume the Work under the special conditions provided by the Construction Manager.

5. Owner may have this deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

G. Contractor may submit a Change Proposal or Owner may impose a set-off if an agreement is not reached within 10 days of Construction Manager's notice regarding the resumption of Work as to whether Contractor is entitled to an adjustment in Contract Price or Contract Times or on the amount or extent of adjustments resulting from this Work stoppage or special conditions under which Contractor agrees to resume Work.

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

ARTICLE 6 – BONDS AND INSURANCE

6.01 Performance, Payment, and Other Bonds

A. Furnish a performance bond in an amount equal to the Contract Price as security for the faithful performance of Work. Contractor is to use amounts paid by Owner to Contractor under the Contract for the performance of the Contract. This bond is to remain in effect until 1 year after the date of final payment.

B. Furnish a payment bond in an amount equal to the Contract Price as security to ensure payment of Contractor's obligations under the Contract Documents. This bond is to remain in effect until 1 year after the date of final payment.

1. Notify the Construction Manager of claims filed against the payment bond. Notify the claimant and Construction Manager of undisputed amounts and the basis for challenging disputed amounts when a claimant has satisfied the conditions prescribed by Laws and Regulations. Promptly pay undisputed amounts.

2. Owner is not liable for payment of costs or expenses of claimants under the payment bond. Owner has no obligations to pay, give notice, or take other action to claimants under the payment bond.

3. OPT will provide a copy of the payment bond and payment information to Subcontractors, Suppliers, or other persons or entities claiming to have furnished labor or materials used in the performance of the Work that request this information in accordance with Laws and Regulations.

C. Notify Construction Manager immediately if the surety on bonds furnished by Contractor:

1. Is declared bankrupt, or becomes insolvent;

2. Has its right to do business in state in which the Project is located is terminated; or

3. Ceases to meet the requirements of Paragraph 6.02.

Provide a bond and surety which comply with the requirements of Paragraph 6.02 within 20 days after the event giving rise to this notification.

D. Furnish other bonds as required by the Contract Documents.

E. Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16 if Contractor fails to obtain or maintain the required bonds.

6.02 Licensed Sureties

A. Provide bonds in the form prescribed by the Contract Documents from sureties named in the U.S. Department of the Treasury's Listing of Approved Sureties (Department Circular 570 "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies").

B. Provide bonds required by the Contract Documents from surety companies that are duly licensed or authorized to provide bonds in the state in which the Project is constructed.

6.03 Insurance

A. Obtain and maintain insurance in accordance with Section 00 73 16 “Insurance Requirements.”

ARTICLE 7 – CONTRACTOR’S RESPONSIBILITIES

7.01 Contractor’s Means and Methods of Construction

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

B. Provide professional engineering or other design services if the Contract Documents require such services or if Contractor determines that such services are needed to carry out Contractor’s responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety. Engineering or other design services are to be provided by a properly licensed design professional authorized to provide these services in the state in which the Project is constructed. Such services are not Owner-delegated professional design services under this Contract, and OPT does not have any responsibility with respect to:

1. Contractor’s determination of the need for such services;
2. The qualifications or licensing of the design professionals retained or employed by Contractor;
3. The performance of such services; or
4. Any errors, omissions, or defects in such services.

7.02 Supervision and Superintendence

A. Supervise, inspect, and direct the performance of the Work.

B. Provide a competent resident superintendent acceptable to the OPT. The resident superintendent or acceptable qualified assistant shall always be present when Work is being done. Cease Work at any time the resident superintendent or acceptable qualified assistant is not on site. Contract is responsible for delays related to stoppage of Work due to the absence of the resident superintendent or acceptable qualified assistant.

C. Do not replace this resident superintendent except under extraordinary circumstances. Provide a replacement resident superintendent equally competent to the previous resident superintendent if replacement is required. Notify the Owner prior to replacing the resident superintendent and obtain Owner’s consent to the change in superintendent.

7.03 Labor; Working Hours

A. Provide competent, suitably qualified personnel to complete the Work. Maintain good discipline and order at the Site. Contractor is responsible for all acts and omissions of Contractor’s Team.

B. Perform Work at the Site during regular working hours except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent to the Site and except as otherwise stated in the Contract Documents.

C. Do not perform Work on a Saturday, Sunday, or Owner-observed holiday without the Construction Manager's consent. If a legal holiday falls on a Saturday, it will be observed the preceding Friday. If a legal holiday falls on a Sunday, it will be observed the following Monday.

D. Pay additional cost incurred by Owner for services of the Construction Manager to observe Work constructed outside of regular working hours. Construction Manager will issue a set-off in the Application for Payment for this cost per Paragraph 15.01.B.

7.04 Services, Materials, and Equipment

A. Provide services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and other facilities and incidentals necessary for the performance, testing, startup, and completion of the Work, whether or not these items are specifically called for in the Contract Documents.

B. Provide new materials and equipment to be incorporated into the Work. Provide special warranties and guarantees required by the Contract Document. Provide satisfactory evidence, including reports of required tests, as to the source, kind, and quality of materials and equipment as required by the Contract Documents or as requested by the Construction Manager.

C. Store, apply, install, connect, erect, protect, use, clean, and condition materials and equipment in accordance with instructions of the applicable Supplier, unless otherwise required by the Contract Documents.

7.05 Concerning Subcontractors and Suppliers

A. Contractor may retain Subcontractors and Suppliers which are acceptable to Owner for the performance of parts of the Work. Contractor must retain specific Subcontractors or Suppliers if required to do so by the Contract Documents. Contractor must use Subcontractors or Suppliers named in the Bid or Proposal if Contractor was selected in part based on these named Subcontractors or Suppliers.

B. Submit a list of proposed Subcontractors and Suppliers to Construction Manager prior to entering into binding subcontracts or purchase orders. These proposed Subcontractors or Suppliers are deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 10 days after receiving this list.

C. Owner may require the replacement of Subcontractors or Suppliers retained by the Contractor. Provide an acceptable replacement for the rejected Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements, subject to Contractor's reasonable objections.

D. Contractor may be entitled to an adjustment in Contract Price or Contract Times with respect to a replacement of Subcontractors or Suppliers required by Owner. Notify Construction Manager immediately if a replacement of Subcontractors or Suppliers increases the Contract Price or Contract Times. Initiate a Change Proposal for the

adjustment within 10 days of Owner's notice to replace a Subcontractor or Supplier. Do not make the replacement until the change in Contract Price or Contract Times has been accepted by the Owner if Change Proposal is to be submitted. The Contractor is not entitled to an adjustment in Contract Price or Contract Times if OPT requires the replacement of the Subcontractor or Supplier based on an unacceptable safety record, lack of experience or qualifications, or other cause.

E. Acceptance by Owner of Subcontractors, Suppliers, or other individuals or entities, whether initially or as a replacement, does not constitute a waiver of the obligation of the Contractor to complete the Work in accordance with the Contract Documents.

F. Maintain a current and complete list of Subcontractors and Suppliers that are to perform or furnish part of the Work.

G. Contractor is fully responsible for the acts and omissions of Subcontractors and Suppliers and is solely responsible for scheduling and coordinating their Work.

H. Require Subcontractors, Suppliers, and other individuals or entities performing or furnishing Work to communicate with OPT through Contractor.

I. Contracts between the Contractor and their Subcontractors or Suppliers may specifically bind the Subcontractors or Suppliers to the applicable terms and conditions of the Contract Documents. Contractor is responsible for meeting the requirements of the Contract Documents if they choose to not bind the Subcontractors or Suppliers to applicable terms or conditions of the Contract Documents.

J. OPT may furnish information about amounts paid to Contractor for Work provided by Subcontractors or Suppliers to the entity providing the Work.

K. Nothing in the Contract Documents:

1. Creates a contractual relationship between members of the OPT and members of the Contractor's Team.

2. Creates an obligation on the part of the Owner to pay or to see to the payment of money due members of the Contractor's Team, except as may be required by Laws and Regulations.

7.06 Patent Fees and Royalties

A. Pay license fees, royalties, and costs incident to the use of inventions, designs, processes, products, or devices which are patented or copyrighted by others in the performance of the Work, or to incorporate these inventions, designs, processes, products, or devices which are patented or copyrighted by others in the Work. The Contract Documents identify inventions, designs, processes, products, or devices OPT knows are patented or copyrighted by others, or that its use is subject to patent rights or copyrights calling for the payment of a license fee or royalty to others. Contractor is to include the cost associated with the use of patented or copyrighted products or processes, whether specified or selected by the Contractor, in the Contract Price.

B. **TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO ANY INFRINGEMENT OF PATENT RIGHTS OR COPYRIGHTS BY CONTRACTOR'S TEAM 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.

7.07 Permits

A. Obtain and pay for construction permits and licenses, and certificates of occupancy, if required. OPT is to assist Contractor in obtaining permits and licenses when required to do so by applicable Laws and Regulations. Pay governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time the Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price.

7.08 Taxes

A. Contractor is responsible for all taxes and duties arising out of the Work. Contractor is responsible for including in the Contract Price any applicable sales and use taxes and is responsible for complying with all applicable Laws and Regulations. Pay sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations.

7.09 Laws and Regulations

A. Give required notices and comply with Laws and Regulations applicable to the performance of the Work. OPT is not responsible for monitoring Contractor's compliance with Laws or Regulations except where expressly required by applicable Laws and Regulations.

B. Pay costs resulting from actions taken by Contractor that are contrary to Laws or Regulations. Contractor is not responsible for determining that the design aspects of the Work described in the Contract Documents is in accordance with Laws and Regulations. This does not relieve Contractor of its obligations under Paragraph 3.03.

C. **TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM ALL CLAIMS AND INDEMNIFIED COSTS RESULTING FROM ACTIONS TAKEN BY CONTRACTOR'S TEAM THAT ARE CONTRARY TO LAWS OR REGULATIONS.**

D. Owner or Contractor may give notice to the other party of changes in Laws or Regulations that may affect the cost or time of performance of the Work, including:

1. Changes in Laws or Regulations affecting procurement of permits; and

2. Sales, use, value-added, consumption, and other similar taxes which come into effect after Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price.

E. Contractor may submit a Change Proposal or Owner may initiate a Claim within 30 days of this notice if Owner and Contractor are unable to agree on entitlement to or on the amount or extent of adjustments in Contract Price or Contract Times resulting from these changes.

7.10 Safety and Protection

A. Contractor is solely responsible for initiating, maintaining, and supervising safety precautions and programs relating to the Work. This responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the

performance of their Work, nor for compliance with applicable safety Laws and Regulations.

B. Take necessary precautions for the safety of persons on the Site or who may be affected by the Work, and provide the necessary protection to prevent damage, injury, or loss to:

1. Work and materials and equipment to be incorporated in the Work, whether stored on or off the Site; and

2. Other property at or adjacent to the Site, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement during construction.

C. Comply with applicable Laws and Regulations relating to the safety and protection of persons or property. Erect and maintain necessary safeguards for safety and protection. Notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site when prosecution of the Work may affect them. Cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

D. Remedy damage, injury, or loss to property referred to in Paragraph 7.09.B caused by Contractor's Team. Pay remediation costs unless the damage or loss is:

1. Attributable to the fault of the Contract Documents,

2. Attributable to acts or omissions of OPT, or

3. Not attributable to the actions or failure to act of the Contractor's Team.

E. Contractor's duties and responsibilities for safety and protection of persons or the Work or property at or adjacent to the Site continues until Work is completed and resumes whenever Contractor's Team returns to the Site to fulfill warranty or correction obligations or to conduct other tasks.

F. Comply with the applicable requirements of the Owner's safety program if required to do so in the Supplementary Conditions. A copy of the Owner's safety program will be provided in the Bidding Documents or Proposal Documents.

G. Provide a qualified and experienced safety representative at the Site whose duties and responsibilities are the prevention of accidents and maintaining and supervising safety programs.

7.11 Hazard Communication Programs

A. Coordinate the exchange of safety data sheets or other hazard communication information required to be made available or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.12 Emergencies

A. Act to prevent threatened damage, injury, or loss in emergencies affecting the safety or protection of persons or the Work or property at or adjacent to the Site. Notify Construction Manager immediately if Contractor believes that significant changes in the Work or variations from the Contract Documents have been caused or are required because of this need to act. A Modification is to be issued by Construction Manager if OPT

determines that the incident giving rise to the emergency action was not the responsibility of the Contractor and that a change in the Contract Documents is required because of the action taken by Contractor in response to this emergency.

7.13 Contractor's General Warranty and Guarantee

A. Contractor warrants and guarantees to Owner that Work is in accordance with the Contract Documents and is not Defective. Owner is entitled to rely on Contractor's warranty and guarantee. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 7.14. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.13 is limited only by applicable Laws and Regulations restricting actions to enforce such rights. Assume and bear responsibility for costs and time delays associated with variations from the requirements of the Contract Documents.

B. Contractor's warranty and guarantee excludes defects or damage caused by abuse, improper maintenance or operation, or modification by OPT; or normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete Work in accordance with the Contract Documents is absolute. None of the following constitute an acceptance of Defective Work, a release of Contractor's obligation to perform Work in accordance with the Contract Documents, or a release of Owner's warranty or guarantee rights under this Paragraph 7.13:

1. Observations by OPT;
2. Recommendation by Construction Manager or payment by Owner of progress or final payments;
3. The issuance of a certificate of Substantial Completion;
4. The issuance of a certificate of Final Completion;
5. The end of the correction period established in Paragraph 7.14;
6. Use or occupancy of part of the Work by Owner;
7. Review and approval of a Shop Drawing or Sample;
8. Inspections, tests, or approvals by others; or
9. Correction of Defective Work by Owner.

D. The Contract Documents may require the Contractor to accept the assignment of a contract between the Owner and a contractor or supplier. The specific warranties, guarantees, and correction obligations contained in an assigned contract govern with respect to Contractor's performance obligations to Owner for the Work described in an assigned contract.

7.14 Correction Period

A. Promptly correct Defective Work without cost to Owner for 1 year after the date of Substantial Completion or longer periods of time prescribed by the terms of the Contract Documents.

B. Promptly correct damages to the Site or adjacent areas that Contractor has arranged to use through construction easements or other agreements. Promptly correct damages to Work or the work of others. Make corrections without cost to Owner.

C. Owner may have the Defective Work and damages described in Paragraphs 7.14.A and 7.14.B corrected if Contractor does not comply with the terms of Construction Manager's instructions, or in an emergency where delay would cause serious risk of loss or damage.

D. **NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS AGREEMENT OR THE CONTRACT DOCUMENTS AND TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, THE CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE CORRECTION OF DEFECTIVE WORK.**

E. The correction period starts to run from the date when a specific item of equipment or systems are placed in continuous beneficial use by Owner before Substantial Completion of Work if so provided in the Specifications or if accepted for beneficial use by the Owner.

F. The correction period is extended for an additional period of 1 year for Defective Work corrected after the date of Substantial Completion or after the accepted date the correction period starts to run as described in Paragraph 7.14.E. This extended correction period starts to run when Defective Work has been satisfactorily corrected under this Paragraph 7.14.

G. Contractor's obligations under this Paragraph 7.14 are in addition to other obligations or warranties. The provisions of this Paragraph 7.14 are not a substitute for, or a waiver of, the provisions of applicable statutes of limitation or repose.

7.15 Indemnification

A. **CONTRACTOR DOES HEREBY AGREE TO WAIVE ALL CLAIMS, RELEASE, INDEMNIFY, DEFEND AND HOLD HARMLESS THE CITY OF ARLINGTON AND ALL OF ITS OFFICIALS, OFFICERS, AGENTS, EMPLOYEES, IN BOTH THEIR PUBLIC AND PRIVATE CAPACITIES, FROM AND AGAINST ANY AND ALL LIABILITY, CLAIMS, LOSSES, DAMAGES, SUITS, DEMANDS OR CAUSES OF ACTION INCLUDING ALL EXPENSES OF LITIGATION AND/OR SETTLEMENT, COURT COSTS AND ATTORNEY FEES WHICH MAY ARISE BY REASON OF INJURY TO OR DEATH OF ANY PERSON OR FOR LOSS OF, DAMAGE TO, OR LOSS OF USE OF PROPERTY OCCASIONED BY ERROR, OMISSION, OR NEGLIGENT ACT OF CONTRACTOR, HIS OFFICERS, AGENTS, EMPLOYEES, SUBCONTRACTORS, INVITEES OR ANY OTHER PERSONS, ARISING OUT OF OR IN CONNECTION WITH THE PERFORMANCE OF THIS CONTRACT, AND CONTRACTOR WILL AT HIS OR HER OWN COST AND EXPENSE DEFEND AND PROTECT CITY OF ARLINGTON FROM ANY AND ALL SUCH CLAIMS AND DEMANDS. CONTRACTOR DOES HEREBY AGREE TO WAIVE ALL CLAIMS, RELEASE, INDEMNIFY, DEFEND AND HOLD HARMLESS CITY OF ARLINGTON AND ALL ITS OFFICIALS, OFFICERS, AGENTS, AND EMPLOYEES, FROM AND AGAINST ANY AND ALL CLAIMS, LOSSES, DAMAGES, SUITS, DEMANDS OR CAUSES OR ACTION, AND LIABILITY OF EVERY KIND INCLUDING ALL EXPENSES OF LITIGATION AND/OR SETTLEMENT, COURT COSTS AND ATTORNEY'S FEES FOR INJURY OR DEATH OF ANY PERSON OR FOR LOSS OF, DAMAGE TO, OR LOSS OF USE OF ANY PROPERTY, ARISING OUT OF OR IN CONNECTION WITH THE PERFORMANCE OF THIS CONTRACT. SUCH INDEMNITY SHALL APPLY WHETHER THE CLAIMS, LOSSES, DAMAGES, SUITS, DEMANDS, OR CAUSES OF ACTION ARISE IN WHOLE OR IN PART FROM**

THE NEGLIGENCE OF THE CITY OF ARLINGTON, HIS OFFICERS, OFFICIALS, AGENTS OR EMPLOYEES. IT IS THE EXPRESS INTENTION OF ALL THE PARTIES THAT THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH IS INDEMNITY BY CONTRACTOR TO INDEMNIFY AND PROTECT CITY OF ARLINGTON FROM THE CONSEQUENCES OF CITY OF ARLINGTON'S OWN NEGLIGENCE, WHETHER THAT NEGLIGENCE IS A SOLE OR CONCURRING CAUSE OF THE INJURY, DEATH OR DAMAGE AND WHETHER SAID NEGLIGENCE IS CHARACTERIZED AS SOLE, CONTRACTUAL COMPARATIVE, CONCURRENT, JOINT, GROSS, ACTIVE, PASSIVE, OR ANY OTHER FORM OF NEGLIGENCE.

B. **THE INDEMNIFICATION OBLIGATION UNDER PARAGRAPH 7.15.A IS NOT LIMITED BY THE AMOUNT OR TYPE OF DAMAGES, COMPENSATION, OR BENEFITS PAYABLE BY OR FOR MEMBERS OF THE CONTRACTOR'S TEAM OR OTHER INDIVIDUALS OR ENTITIES UNDER WORKERS' COMPENSATION ACTS, DISABILITY BENEFIT ACTS, OR OTHER EMPLOYEE BENEFIT ACTS IN CLAIMS AGAINST OWNER'S INDEMNITEES BY AN EMPLOYEE OR THE SURVIVOR OR PERSONAL REPRESENTATIVE OF EMPLOYEE OF CONTRACTOR'S TEAM**.

C. **THE INDEMNIFICATION OBLIGATIONS OF CONTRACTOR UNDER PARAGRAPH 7.15.A DO NOT EXTEND TO THE LIABILITY OF DESIGN PROFESSIONAL ARISING OUT OF THE PREPARATION OF THE CONTRACT DOCUMENTS OR GIVING DIRECTIONS OR INSTRUCTIONS, OR FAILING TO GIVE THEM, TO THE EXTENT THEY ARE OBLIGATED TO DO SO IF THAT IS THE PRIMARY CAUSE OF THE INJURY OR DAMAGE.**

7.16 Delegation of Professional Design Services

A. Contractor is to provide professional design services required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures.

B. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. This delegation will specify the performance and design criteria that such services must satisfy and the Submittals that Contractor must furnish to Construction Manager with respect to the Owner delegated design. Contractor is not required to provide these professional services in violation of applicable Laws and Regulations.

C. Owner-delegated professional design services provided through the Contractor are to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and other Submittals prepared by such design professional. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Construction Manager, then such Shop Drawing or other Submittal must bear the design professional's written approval when submitted by Contractor to Construction Manager.

D. OPT is entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by Contractor's design professionals, provided OPT has specified to Contractor the performance and design criteria that these services must satisfy.

E. Pursuant to this Paragraph 7.16, OPT's review and approval of design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.16;
2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor is not responsible for the adequacy of the performance or design criteria specified by OPT. Advise OPT if the performance or design criteria are known or considered likely to be inadequate or otherwise deficient.

ARTICLE 8 – OTHER WORK AT THE SITE

8.01 Other Work

A. Owner may arrange for other work at or adjacent to the Site which is not part of the Contractor's Work. This work may be performed by Owner's employees or through other contractors. Utility owners may perform work on their utilities and facilities at or adjacent to the Site. Include costs associated with coordinating with entities performing other work or associated with connecting to other work in the Contract Price if other work is shown in the Contract Documents.

B. OPT is to notify Contractor of other work prior to starting the work and provide any knowledge they have regarding the start of utility work at or adjacent to the Site to Contractor.

C. Provide other contractors:

1. Proper and safe access to the Site;
2. Reasonable opportunity for the introduction and storage of materials and equipment; and
3. Reasonable opportunity to execute their work.

D. Provide cutting, fitting, and patching of the Work required to properly connect or integrate with other work. Do not endanger the work of others by cutting, excavating, or otherwise altering the work of others without the consent of Construction Manager and the others whose work will be affected.

E. Inspect the work of others and immediately notify Construction Manager if the proper execution of part of Contractor's Work depends upon work performed by others and this work has not been performed or is unsuitable for the proper execution of Contractor's Work. Contractor's failure to notify the Construction Manager constitutes an acceptance of this other work as acceptable for integration with Contractor's Work. This acceptance does not apply to latent defects or deficiencies in the work of others.

F. Take adequate measures to prevent damages, delays, disruptions, or interference with the work of Owner, other contractors, or utility owners performing other work at or adjacent to the Site.

G. The provisions of this Article 8 are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.03.

8.02 Coordination

A. Owner has sole authority and responsibility for coordination of other work unless otherwise provided in the Contract Documents. The Owner is to identify the entity with authority and responsibility for coordination of the activities of the various contractors, the limitations of their authority, and the work to be coordinated prior to the start of other work at or adjacent to the Site.

8.03 Legal Relationships

A. Contractor may be entitled to a change in Contract Price or Contract Times if, while performing other work at or adjacent to the Site for Owner, the OPT, other contractor, or utility owner:

1. Damages the Work or property of Contractor's Team;

2. Delays, disrupts, or interferes with the execution of the Work; or

3. Increases the scope or cost of performing the Work through their actions or inaction.

B. Notify the Construction Manager immediately of the event leading to a potential Change Proposal so corrective or mitigating action can be taken. Submit the Change Proposal within 30 days of the event if corrective action has not adequately mitigated the impact of the actions or inactions of others. Information regarding this other work in the Contract Documents is used to determine if the Contractor is entitled to a change in Contract Price or Contract Times. Changes in Contract Price require that Contractor assign rights against the other contractor or utility owner to Owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Changes in Contract Times require that the time extension is essential to Contractor's ability to complete the Work within the Contract Times.

C. Take prompt corrective action if Contractor's Team damages, delays, disrupts, or interferes with the work of Owner's employees, other contractors, or utility owners performing other work at or adjacent to the Site or agree to compensate other contractors or utility owners for correcting the damage. Promptly attempt to settle claims with other contractors or utility owners if Contractor damages, delays, disrupts, or interferes with the work of other contractors or utility owners performing other work at or adjacent to the Site.

D. Owner may impose a set-off against payments due to Contractor and assign the Owner's contractual rights against Contractor with respect to the breach of the obligations described in this Paragraph 8.03 to other contractors or utility owners if damages, delays, disruptions, or interference occur.

E. **NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS AGREEMENT OR THE CONTRACT DOCUMENTS AND TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, THE CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS RESULTING FROM**

CONTRACTOR'S TEAM'S ACTION OR INACTION RELATED TO DAMAGES, DELAYS, DISRUPTIONS, OR INTERFERENCE WITH THE WORK OF OWNER'S EMPLOYEES, OTHER CONTRACTORS, OR UTILITY OWNERS PERFORMING OTHER WORK AT OR ADJACENT TO THE SITE.

ARTICLE 9 – OWNER'S AND OPT'S RESPONSIBILITIES

9.01 Communications to Contractor

A. OPT is to issue communications to Contractor through the Construction Manager except as otherwise provided in the Contract Documents.

9.02 Replacement of OPT Members

A. Owner may replace members of the OPT at its discretion.

9.03 Furnish Data

A. OPT is to furnish the data required of OPT under the Contract Documents.

9.04 Pay When Due

A. Owner is to make payments to Contractor when due as described in Paragraphs 15.01.D and 15.06.D.

9.05 Lands and Easements; Reports and Tests

A. Owner's duties with respect to providing lands and easements are described in Paragraph 5.01. OPT will make 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 available to Contractor in accordance with Paragraph 5.03.

9.06 Insurance

A. Owner's responsibilities with respect to purchasing and maintaining insurance are described in Section 00 73 16 "Insurance Requirements."

9.07 Modifications

A. Owner's responsibilities with respect to Modifications are described in Article 11.

9.08 Inspections, Tests, and Approvals

A. OPT's responsibility with respect to certain inspections, tests, and approvals are described in Paragraph 14.02.

9.09 Limitations on OPT's Responsibilities

A. The OPT does not supervise, direct, or have control or authority over, and is not responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or related safety precautions and programs, or for failure of Contractor to comply with Laws

and Regulations applicable to the performance of the Work. OPT is not responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

B. OPT is not responsible for the acts or omissions of Contractor's Team. No actions or failure to act, or decisions made in good faith to exercise or not exercise the authority or responsibility available under the Contract Documents creates a duty in contract, tort, or otherwise of the OPT to the Contractor or members of the Contractor's Team.

9.10 Undisclosed Hazardous Environmental Condition

A. OPT's responsibility for undisclosed Hazardous Environmental Conditions is described in Paragraph 5.06.

9.11 Compliance with Safety Program

A. Contractor is to inform the OPT of its safety programs and OPT is to comply with the specific applicable requirements of this program.

ARTICLE 10 – DESIGN PROFESSIONAL'S AND CONSTRUCTION MANAGER'S STATUS DURING CONSTRUCTION

10.01 Owner's Representative

A. Construction Manager is the Owner's representative. The duties and responsibilities and the limitations of authority of Construction Manager as Owner's representative are described in the Contract Documents.

10.02 Visits to Site

A. Design Professional is to make periodic visits to the Site to observe the progress and quality of the Work. Design Professional is to determine, in general, if the Work is proceeding in accordance with the Contract Documents based on observations made during these visits. Design Professional is not required to make exhaustive or continuous inspections to check the quality or quantity of the Work. Design Professional is to inform the OPT of issues or concerns and Construction Manager is to work with Contractor to address these issues or concerns. Design Professional's visits and observations are subject to the limitations on Design Professional's authority and responsibility described in Paragraph 9.09.

B. Construction Manager is to observe the Work to check the quality and quantity of Work, implement Owner's quality assurance program and administer the Contract as Owner's representative as described in the Contract Documents. Construction Manager's visits and observations are subject to the limitations on Construction Manager's authority and responsibility described in Paragraph 9.09.

10.03 Rejecting Defective Work

A. OPT has the authority to reject Work in accordance with Article 14. Construction Manager is to notify Contractor of Defective Work of which it is aware and document when Defective Work has been corrected or accepted in accordance with Article 14.

10.04 Decisions on Requirements of Contract Documents and Acceptability of Work

A. Construction Manager is to render decisions regarding non-technical or contractual/administrative requirements of the Contract Documents and will coordinate the response of the OPT to Contractor.

B. Design Professional is to render decisions regarding the conformance of the Work to the requirements of the Contract Documents. Design Professional will render a decision to either correct the Defective Work, or accept the Work under the provisions of Paragraph 14.04, if Work does not conform to the Contract Documents. Construction Manager will coordinate the response of the OPT to Contractor.

C. Construction Manager will issue a Request for a Change Proposal if a Modification is required. Construction Manager will provide documentation for changes related to the non-technical or contractual/administrative requirements of the Contract Documents. Design Professional will provide documentation if design related changes are required through the Construction Manager.

D. Contractor may appeal OPT's decision by submitting a Change Proposal if Contractor does not agree with the OPT's decision.

ARTICLE 11 – CHANGES TO THE CONTRACT

11.01 Amending and Supplementing the Contract Documents

A. A Contract Amendment, Change Order, Work Change Directive, or Field Order may modify the Contract Documents. Modifications that include a change in the Contract Price or Contract Times can only be made in a Contract Amendment or Change Order.

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

C. Proceed with the Changes in the Work or, in the case of a deletion in the Work, immediately cease construction activities related to the deleted Work upon receipt of the Modification.

D. Contractor is not entitled to an increase in the Contract Price or an extension of the Contract Times with respect to Work performed that is not required by the Contract Documents, except in the case of an emergency as provided in Paragraph 7.12 or in the case of uncovering Work as provided in Paragraph 14.05. Contractor is responsible for costs and time delays associated with variations from the requirements of the Contract Documents unless the variations are specifically approved by Change Order.

E. Acceptance of a Modification by Contractor constitutes agreement that the compensation provided by that Modification is the full, complete, and final compensation for all costs the Contractor has or may incur because of or relating to this Modification whether these costs are known, unknown, foreseen, or unforeseen at this time, including any cost for delay, extended overhead, ripple or impact cost, or any other effect on changed or unchanged Work as a result of this Modification.

F. Acceptance of a Modification by Contractor constitutes agreement that the changes in Contract Times are the complete and final adjustments for direct impacts to the ability of the Contractor to complete the Work within the Contract Times and are the only adjustments to which the Contractor is entitled.

G. Perform added or revised Work under the applicable provisions of the Contract Documents for the same or similar Work unless different Drawings, Specifications, or directions are provided in the Modification.

H. Nothing in this Paragraph 11.01 obligates the Contractor to undertake Work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.02 Contract Amendments

A. Owner and Contractor may modify the terms and conditions of the Contract Documents without the recommendation of the Design Professional using a Contract Amendment.

B. A Contract Amendment may also be used for authorizing a new task order for task order contracts or a new phase of the Work when using phased construction or purchasing Goods and Special Services to be incorporated into the Project. The Contract Amendment may be used to establish the Contract Price, Contract Times, or terms and conditions of the Contract for the new task order or phase of Work if not already established in the Contract Documents.

11.03 Change Orders

A. All changes to the Contract Documents that include a change in the Contract Price or the Contract Times for previously authorized Work and changes to the Work requiring Design Professional's approval must be made by a Change Order. Change Orders prepared by the Construction Manager may cover:

1. Changes in Contract Price or Contract Times which are submitted by Contractor as a Change Proposal and agreed to by the parties;

2. Changes in Contract Price or Contract Times to pay for undisputed Work performed in accordance with a Work Change Directive;

3. Changes in Contract Price or Contract Times making final adjustments for Work covered under alternates and allowances;

4. Changes in Contract Price or Contract Times making final adjustments to actual quantities for Unit Price Work;

5. Changes in Contract Price resulting from an Owner set-off, unless the set-off has been successfully challenged by Contractor

6. Changes in Contract Price or Contract Times resulting from resolution of Claims;

7. Changes in Contract Price or Contract Times required because of Owner's acceptance of Defective Work under Paragraph 14.04 or Owner's correction of Defective Work under Paragraph 14.07, or

8. Other similar provisions that will modify the Contract Price or Contract Times.

B. A Change Order may also be used to establish modifications of the Contract Documents that do not affect the Contract Price or Contract Times.

C. Work covered under a Change Order cannot start until the Change Order is approved.

11.04 Work Change Directives

A. A Work Change Directive does not change the Contract Price or the Contract Times, but is evidence that the parties expect that the modifications ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations on the Contract Price and Contract Times.

B. Contractor must submit a Change Proposal seeking an adjustment of the Contract Price or the Contract Times no later than 30 days after the completion of the Work set out in the Work Change Directive if negotiations are unsuccessful under the terms of the Contract Documents governing adjustments, expressly including Paragraphs 11.04 and 11.05.

11.05 Field Orders

A. Design Professional may require minor changes in the Work that do not change the Contract Price or Contract Times using a Field Order issued through the Construction Manager. Construction Manager may issue a Field Order for non-technical, administrative issues. Submit a Change Proposal if Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times before proceeding with the Work described in the Field Order.

11.06 Change Proposals

A. Submit a Change Proposal to the Construction Manager to:

1. Request an adjustment in the Contract Price or Contract Times;

2. Contest an initial decision by OPT concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents;

3. Contest a set-off against payment due; or

4. Seek other relief under the Contract Documents.

B. Notify the Construction Manager immediately if a Change Proposal is to be submitted. Submit each Change Proposal to Construction Manager no later than 30 days after the event initiating the Change Proposal. Submit the following as part of the Change Proposal:

1. Any proposed change in Contract Price, Contract Times, or other relief, accompanied by a statement that the requested Change Order is the entire adjustment to which Contractor believes it is entitled;

2. The reason for the proposed change; and

3. Supporting data, accompanied by a statement that the supporting data is accurate and complete.

C. Construction Manager is to advise OPT regarding the Change Proposal. OPT is to review each Change Proposal and Contractor's supporting data, and within 30 days after receipt of the documents, direct the Construction Manager to either approve or deny the Change

Proposal in whole or in part. Construction Manager is to issue a Change Order for an approved Change Proposal. Change Proposals are denied if Construction Manager does not act on the Change Proposal within 30 days. Contractor may start the time for appeal of the under Article 12 after the Change Proposal is denied.

11.07 Change of Contract Price; Contract Times

A. Change Proposals for an adjustment in the Contract Price must comply with the provisions of this Paragraph 11.07. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12. An adjustment of the Contract Times is subject to the limitations described in Paragraph 4.03.

B. An adjustment in the Contract Price is to be determined as follows:

1. By applying unit prices to the quantities of the items involved, subject to the provisions of Paragraph 13.03, where the Work involved is covered by unit prices in the Contract Documents;

2. By a mutually agreed lump sum where the Work involved is not covered by unit prices in the Contract Documents; or

3. Payment based on the Cost of the Work determined as provided in Article 13 when the Work involved is not covered by unit prices in the Contract Documents or the parties do not reach a mutual agreement to a lump sum.

C. The original Contract Price may not be increased by more than 25 percent unless further limited by Laws and Regulations. Owner may decrease the Work by up to 25 percent of the Contract Price without adjusting Contractor's fee.

11.08 Execution of Change Orders and Contract Amendments

A. Each Change Order or Contract Amendment must be specific and final as to changes in Contract Price and Contract Times for the changes described in the Change Order or Contract Amendment. Acceptance of a Change Order or Contract Amendment by Contractor constitutes a full accord and satisfaction for all claims and costs of any kind, whether direct or indirect, including impact, delay, or acceleration damages related to the Change Order or Contract Amendment. The execution of a Change Order or Contract Amendment by Contractor constitutes conclusive evidence of Contractor's agreement to the ordered changes in the Work, with no reservations or other provisions allowing for future changes in the Contract Price or Contract Times. This Contract, as amended, forever releases any claim against Owner for additional time or compensation for matters relating to or arising out of or resulting from the Work included within or affected by the executed Change Order or Contract Amendment. This release applies to claims related to the cumulative impact of all Change Orders or Contract Amendment and to any claim related to the effect of a change on unchanged Work.

B. A Change Order or Contract Amendment is deemed to be in full force as if executed by Contractor if the Contractor refuses to execute a Change Order or Contract Amendment that is required to be executed under the terms of this Paragraph 11.08.

11.09 Notice to Surety

A. Notify the surety of Modifications affecting the general scope of the Work, changes in the provisions of the Contract Documents, or changes in Contract Price or Contract Times. Adjust the amount of each bond when Modifications change the Contract Price.

ARTICLE 12 – CLAIMS

12.01 Claims

A. Follow the Claims process described in this Article for a demand or assertion by Contractor:

1. Contesting an initial decision by OPT concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents;
2. Contesting OPT's decision regarding a Change Proposal;
3. Seeking resolution of a contractual issue that OPT has declined to address;
4. Seeking other relief with respect to the terms of the Contract; or
5. Any issue, request, demand, or dispute arising after Construction Manager's recommendation of Final Payment not specifically listed in the Certificate of Final Completion.

B. Notify the Construction Manager no later than 7 days after the start of the event giving rise to the Claim or, in the case of appeals regarding Change Proposals, within 7 days of the decision under appeal. The responsibility to substantiate a Claim rests with the entity making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Price or Contract Times, Contractor must certify that the Claim is made in good faith, that the supporting data is accurate and complete, and that to the best of Contractor's knowledge and belief, the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. The entity receiving a Claim is to review the Claim and consider its merits. The Owner and Contractor are to seek to resolve the Claim through the exchange of information and direct negotiations. The Owner and Contractor may extend the time for resolving the Claim by mutual agreement. Notify Construction Manager of actions taken on a Claim.

D. Owner and Contractor may mutually agree to mediate the underlying dispute at any time after initiation of a Claim.

1. The agreement to mediate suspends the Claims process.
2. Owner or Contractor may unilaterally terminate the mediation process after 60 days from the agreement to mediate and resume the Claims process as of the date of the termination. The Claim process resumes as of the date of the conclusion of the mediation, as determined by the mediator, if the mediation is unsuccessful in resolving the dispute.
3. Owner and Contractor are to each pay one-half of the mediator's fees and costs.

E. If the entity receiving a Claim approves the Claim in part or denies it in part, this action is final and binding unless the other entity invokes the procedure described in Article 17 for final resolution of disputes within 30 days of this action.

F. Notify the Construction Manager if efforts to resolve the Claim are not successful and the Claim is denied. A denial of the Claim is final and binding unless the other entity invokes the procedure described in Article 17 for the final resolution of disputes within 30 days of the denial.

G. The results of the agreement or action on the Claim is to be incorporated in a Change Order by the Construction Manager to the extent they affect the Contract Documents, the Contract Price, or the Contract Times if the Owner and Contractor reach an agreement regarding a Claim.

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

13.01 Cost of the Work

A. The Cost of the Work is the sum of costs described in this Paragraph 13.01, except those excluded in Paragraph 13.01.D, necessary for the proper performance of the Work. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price under cost-plus, time-and-materials, or other cost-based terms; or

2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price.

B. Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the events giving rise to the adjustment when the value of the adjustment is determined based on the Cost of the Work.

C. Costs included in the Cost of the Work may not exceed the costs commonly incurred in the proximate area of the Site for similar work unless agreed to by the Owner. Cost of the Work includes only the following items:

1. Payroll costs for Contractor's employees performing the Work, including one foreman per crew, and other required and agreed upon personnel for the time they are employed on the Work. Employees are to be paid according to wage rates for job classifications as agreed to by Owner in advance of the Work. Rates paid for this Work are to be the same as paid for Contract Work as established by certified payroll. Payroll costs may include:

a. Actual costs paid for salaries and wages;

b. Actual cost paid for fringe benefits, which consists of:

1) Social security contributions,

2) Unemployment,

3) Excise and payroll taxes,

4) Workers' compensation,

5) Health and retirement benefits, and

6) Paid time off for sick leave, vacations and holidays; and

c. Actual cost of additional compensation paid for performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, to the extent authorized by Owner.

2. Cost of materials and equipment furnished and incorporated in the Work, including transportation and storage costs, and required Suppliers' field services. Contractor may retain cash discounts unless Owner provided funds to the Contractor for early payment of these materials and equipment. Cash discounts are to be credited to Owner if the Owner provides funds for early payment. Make provisions for trade discounts, rebates, refunds, and returns from sale of surplus materials and equipment and reduce the Cost of the Work by these amounts.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. Obtain competitive bids from Subcontractors acceptable to Owner if required by the OPT. Bids are to be opened in the presence of the Construction Manager and other designated members for the OPT. Provide copies of bids to the Construction Manager to use in determining, with the OPT, which bids are acceptable. The Subcontractor's Cost of the Work and fee are determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01 if the subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee.

4. Supplemental costs consisting of the following:

   a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work;

   b. Costs of materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site including transportation and maintenance costs related specifically to the Work;

   c. Costs of engineers, architects, testing laboratories, surveyors, employed or retained for services specifically related to the Work.

   d. Actual cost for construction equipment, including the costs of transporting, loading, unloading, assembling, dismantling, and removing construction equipment, whether owned by Contractor or rented from others.

      1) Cost for construction equipment must not exceed the cost shown in the most current edition of the EquipmentWatch Cost Recovery Rental Rate Blue Book. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.

      2) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

e. Applicable sales, consumer, use, and other similar taxes related to the Work for which the Owner is not exempt, and which Contractor pays consistent with Laws and Regulations;

f. Deposits lost for causes other than negligence of Contractor's Team;

g. Royalty payments and fees for permits and licenses;

h. Cost of additional utilities, fuel, and sanitary facilities at the Site;

i. Minor expense items directly required by the Work; and

j. Premiums for bonds and insurance required by the Contract Documents.

D. The Cost of the Work does not include the following administrative costs which are to be covered by the Contractor's fee:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, safety managers, superintendents, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office, for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.C.1.

2. The cost of purchasing, renting, or furnishing any tool or equipment whose current price would be less than $500 if purchased new at retail.

3. Office expenses other than Contractor's office at the Site.

4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

5. Costs due to the actions of Contractor's Team for the correction of Defective Work, disposal of materials or equipment that do not comply with Specifications, and correcting damage to property.

6. Losses, damages, and related expenses caused by damage to the Work or sustained by Contractor in connection with the performance of the Work. Contractor is entitled to recover costs if covered by Owner's insurance, if applicable. Such losses may include settlements made with the approval of Owner. Do not include these losses, damages, and expenses in the Cost of the Work when determining Contractor's fee.

7. Expenses incurred in preparing and advancing Claims.

8. Any Indemnified Costs paid regarding Contractor's indemnification of Owner's Indemnitees.

9. Other overhead or general expense costs and the costs of items not described in Paragraph 13.01.C.

10. The Contractor's fee is determined in accordance with the Agreement when the Work is performed on a cost-plus basis.

E. The Contractors Fee is determined as follows for Work included in a Change Proposal.

1. The Contractor's fee is 15 percent of the costs included in the Cost of the Work per Paragraph 13.01.C.1 for payroll costs and per Paragraph 13.01.C.2 for cost of materials and equipment furnished and incorporated in the Work.

2. The Contractor's fee is 5 percent of costs included in the Cost of the Work paid by Contractor for Work performed by Subcontractors per Paragraph 13.01.C.3.

3. No fee will be payable for costs included in the Cost of the Work for supplemental costs per Paragraph 13.01.C.4.

4. Fees are to be determined as follows where one or more tiers of Subcontracts are used:

a. The Subcontractor's fee is 15 percent for costs incurred under Paragraphs 13.01.C (excluding Paragraph 13.01.C.3) for the Subcontractor that performs the Work;

b. The Contractor and Subcontractors of a tier higher than that of the Subcontractor that performs the Work are allowed a fee of 5 percent of the total costs incurred by the next lower tier Subcontractor; and

c. Regardless of the number of subcontractor tiers involved, the maximum total fee to be paid by the Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that performs the Work.

F. When a Change Proposal includes additions and credits, the Contractor's fee will be calculated on the sum of costs for each cost category in Paragraph 13.01.C. and applying the appropriate fee from Paragraph 13.01.E. The amount to be credited by Contractor to Owner for any Change Proposal which results in a net decrease in the Cost of Work will be the amount of the actual net decrease in the Cost of Work plus an additional amount equal to 5 percent of the actual net decrease in the Cost of Work.

G. Establish and maintain records in accordance with generally accepted accounting practices and submit these records, including an itemized cost breakdown together with supporting data, in a form and at intervals acceptable to Construction Manager whenever the Cost of the Work is to be determined pursuant to this Paragraph 13.01.

13.02 Allowances

A. Include allowances specified in the Contract Documents in the Contract Price and provide Work covered by the allowance as authorized by the Owner through the Construction Manager.

B. Contractor agrees that:

1. The cash allowance is used to compensate the Contractor for the cost of furnishing materials and equipment for the Work covered by the allowance item in the Contract Documents. Cost may include applicable taxes. Make provisions for trade discounts, rebates, and refunds and reduce the allowance costs by these amounts.

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances; and

3. Costs for cash allowances and installation costs as described in Paragraphs 13.02.B.1 and 13.02.B.2 above are included in the Contract Price.

C. Construction Manager will issue a Change Order to adjust the Contract Price by the difference between the allowance amount and the actual amount paid by Contractor for Work covered by the allowance. The Change Order will be issued at the time costs are incurred by Contractor for Work covered by the allowance and this Work is included on the Application for Payment.

13.03 Unit Price Work

A. The initial Contract Price for Unit Price Work is equal to the sum of the unit price line items in the Agreement. Each unit price line item amount is equal to the product of the unit price for each line item 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 comparing offers and determining an initial Contract Price. Payments to Contractor for Unit Price Work are to be based on actual quantities measured for Work in place.

C. Each unit price is deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Construction Manager is to determine the actual quantities and classifications of Unit Price Work performed by Contractor to be incorporated into each Application for Payment. Construction Manager's decision on actual quantities is final and binding, subject to the provisions of Paragraph 13.03.E.

E. Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price within 30 days of Construction Manager's decision under Paragraph 13.03.D, if:

1. The total cost of a particular item of Unit Price Work amounts to 25 percent or more of the total Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by the Contractor differs by more than 25 percent from the estimated quantity of an item indicated in the Agreement;

2. There is no corresponding adjustment with respect to other items of Work; and

3. Contractor believes it has incurred additional expense as a result of this condition or if Owner believes that the quantity variation entitles Owner to an adjustment in the Contract Price.

F. Construction Manager will issue a Change Order adjusting estimated quantities to actual quantities to determine the final Contract Price.

13.04 Contingencies

A. Contingency funds may be included in the Contract Price to pay for Work not defined specifically by the Contract Documents that is essential to the completion of the Project. Contingency funds will be as described in the Agreement.

B. The contingency funds may be used for costs incurred by the Contractor provided these costs are approved by the Owner. Costs are to be determined and documented in

accordance with Paragraph 13.01. The contingency funds are not to be used for the following items:

1. Cost overruns due to changes in material costs after the Contract Price is established, unless specific price escalation provisions are made in the Agreement.
2. Rework required to correct Defective Work.
3. Inefficiencies in completing the Work due to the Contractor's selected means, methods, sequences, or procedures of construction.
4. Work Contractor failed to include in the Contract Price.
5. Changes required by changes in Laws and Regulations enacted after the Contract Price is established.
6. Any Work that does not constitute a change in Scope in the Work included in the Contract Price.

C. Construction Manager is to issue a Change Order for approved expenditures from contingency funds. When the Change Order is issued, the costs are to be added to the Application for Payment. Contractor is to maintain a tabulation showing the contingency amount, adjustments to the contingency amount, and amounts remaining as the Project progresses.

D. Any contingency amounts that are not included in a Change Order are retained by the Owner. A Change Order will be issued to deduct unused contingency amounts from the Contract Price prior to Final Payment.

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

14.01 Access to Work

A. Provide safe access to the Site and the Work for the observation, inspection, and testing of the Work in progress. Contractor can require compliance with Contractor's safety procedures and programs as part of providing safe access.

14.02 Tests, Inspections, and Approvals

A. OPT may retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform inspections. Cooperate with inspection and testing personnel and assist with providing access for required inspections, tests, and handling test specimens or Samples.

B. Arrange for and facilitate inspections, tests, and approvals required by Laws or Regulations of governmental entities having jurisdiction that require Work to be inspected, tested, or approved by an employee or other representative of that entity. Pay associated costs and furnish Construction Manager with the required certificates of inspection or approval.

C. Arrange, obtain, and pay for inspections and tests required:

1. By the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to OPT;

2. To attain OPT's acceptance of materials or equipment to be incorporated in the Work;
3. By manufacturers of equipment furnished under the Contract Documents;
4. For testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work;
5. For acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work;
6. For re-inspecting or retesting Defective Work, including any associated costs incurred by the testing laboratory for cancelled tests or standby time; and
7. For retesting due to failed tests.

D. Provide independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to OPT to provide these inspections and tests.

14.03 Defective Work

A. It is Contractor's obligation to ensure that the Work is not Defective.

B. OPT has the authority to determine whether Work is Defective and to reject Defective Work.

C. Construction Manager is to notify Contractor of Defective Work of which OPT has actual knowledge.

D. Promptly correct Defective Work.

E. Take no action that would void or otherwise impair Owner's special warranties or guarantees when correcting Defective Work.

F. Pay claims, costs, losses, and damages arising out of or relating to Defective Work, including:

1. Costs for correction, removal, and replacement of Defective Work;
2. Cost of the inspection and testing related to correction of Defective Work;
3. Costs for Design Professional's fees associated with review and approval of design modifications for correction, removal, and replacement of Defective Work.
4. Fines levied against Owner by governmental authorities because of Defective Work; and
5. Costs of repair or replacement of work of others resulting from Defective Work.

14.04 Acceptance of Defective Work

A. Owner may elect to accept Defective Work instead of requiring correction or removal and replacement of Defective Work provided:

1. This acceptance occurs prior to final payment;
2. Design Professional confirms that the Defective Work is in general accordance with the design intent and applicable design principles; and

3. Design Professional confirms that acceptance of the Defective Work does not endanger public health or safety.

B. Owner may impose a reasonable set-off against payments due under Article 15 for costs associated with OPT's evaluation of Defective Work to determine if it can be accepted and to determine the diminished value of the Work. Owner may impose a reasonable set-off against payments due under Article 15 if the parties are unable to agree as to the decrease in the Contract Price to compensate Owner for the diminished value of Defective Work accepted. Construction Manager is to issue a Change Order for acceptance of the Defective Work prior to final payment. Pay an appropriate amount to Owner if the acceptance of Defective Work occurs after final payment.

14.05 Uncovering Work

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

B. Work that is covered prior to approval of the Construction Manager must be uncovered for OPT's observation if requested by Construction Manager. Pay for uncovering Work and its subsequent restoration unless Contractor has given Construction Manager timely notice of Contractor's intention to cover the Work and Construction Manager fails to act with reasonable promptness in response to this notice.

C. Provide necessary labor, material, and equipment and uncover, expose, or otherwise make available the portion of the Work suspected of being Defective for observation, inspection, or testing if OPT considers it necessary or advisable that covered Work be observed by Design Professional or inspected or tested by others as directed by the Construction Manager.

1. Pay for claims, costs, losses, and damages associated with uncovering, exposing, observing, inspecting, and testing if it is found that the uncovered Work is Defective. Pay costs for correction of Defective Work. Pay for reconstruction, repair, or replacement of work of others if it is found that the uncovered Work is Defective.

2. Submit a Change Proposal for an increase in the Contract Price or an extension of the Contract Times directly attributable to this uncovering, exposure, observation, inspection, testing, and reconstruction if the uncovered Work is found to not be Defective.

14.06 Owner May Stop the Work

A. Owner may order Contractor to stop the Work if:

1. The Work is Defective;

2. Contractor fails to supply adequate skilled workers or suitable materials or equipment; or

3. Contractor performs Work that may fail to conform to the Contract Documents when completed.

B. This stop work order is to remain in effect until the reason for the stop work order has been eliminated. Owner's right to stop the Work does not create a duty to exercise this right for the benefit of Contractor's Team or surety.

14.07 Owner May Correct Defective Work

A. Owner may remedy Defective Work after 7 days' notice to Contractor if Contractor fails to correct Defective Work, or to remove and replace Defective Work as required by OPT;

B. Owner may:

1. Exclude Contractor from the Site;

2. Take possession of the Work and suspend Contractor's services related to the Work; and

3. Incorporate stored materials and equipment in the Work.

C. Allow OPT access to the Site and off-site storage areas to enable Owner to exercise the rights and remedies under this Paragraph 14.07.

D. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 are to be charged against Contractor as a set-off against payments due under Article 15. These claims, costs, losses, and damages include costs of repair and the cost of replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's Defective Work.

E. Contractor is not allowed an extension of the Contract Times because of delays in the performance of the Work attributable to the exercise of the Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; FINAL COMPLETION

15.01 Progress Payments

A. Progress payments are to be submitted to the Construction Manager on the Application for Payment form provided by the Construction Manager following procedures in the Contract Documents.

1. Progress payments for lump sum Work are to be paid based on the earned value to date at the amounts shown in the Schedule of Values submitted as required by Paragraph 2.03. Final payment will be for the total lump sum amount.

2. Progress payments for Unit Price Work are based on the number of units completed as determined under the provisions of Paragraph 13.03.

3. Progress payments for Work to be paid based on the Cost of the Work per Paragraphs 13.01, 13.02, and 13.04 are to be paid for Work completed by Contractor during the pay period.

B. Reduction in Payment by Owner:

1. Owner is entitled to impose a set-off against payment based on the following:

a. Claims made against Owner or costs, losses, or damages incurred by Owner related to:

1) Contractor's conduct in the performance of the Work, including workplace injuries, non-compliance with Laws and Regulations, or patent infringement; or

2) Contractor's failure to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site, including workplace injuries, property damage, and non-compliance with Laws and Regulations.

b. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

c. Work is Defective, or completed Work has been damaged by Contractor's Team, requiring correction or replacement;

d. Owner has been required to correct Defective Work or complete Work in accordance with Paragraph 14.07;

e. The Contract Price has been reduced by Change Orders;

f. Events have occurred that would constitute a default by Contractor justifying a termination for cause;

g. Liquidated or other damages have accrued because of Contractor's failure to achieve Milestones, Substantial Completion, or completion of the Work;

h. Liens have been filed regarding the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of these Liens;

i. Owner has been notified of failure to make payments to Subcontractors, Suppliers, or Employees;

j. Failure to submit up-to-date record documents as required by the Contract Documents;

k. Failure to submit monthly Progress Schedule updates or revised schedules as requested by the Construction Manager;

l. Failure to provide Project photographs or video required by the Contract Documents;

m. Failure to provide Certified Payroll required by the Contract Documents;

n. Compensation for OPT for overtime charges of Construction Manager and Engineer for third review of Shop Drawings, review of substitutions, re-inspection fees, inspections or designs related to correction of Defective Work, or other services identified as requiring payment by the Contractor;

o. Compensation for OPT charges for Program Manager, Construction Manager, Engineer, Inspectors and other related cost associated with Contractor's failure to meet Contract Times.

p. Costs for tests performed by the Owner to verify that Work previously tested and found to be Defective has been corrected;

q. OPT has actual knowledge of the occurrence of events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents with associated cost impacts;

r. Payment would result in an over-payment of the Contract Price; or

s. Other items entitling Owner to a set-off against the amount recommended.

2. Compensation for services of OPT staff is to be at the rates established in the Supplementary Conditions.

3. Construction Manager is to notify Contractor stating the amount and the reasons for an imposed set-off. The Owner is to pay the Contractor amounts remaining after deduction of the set-off. Owner is to pay the set-off amount agreed to by Owner and Contractor if Contractor remedies the reasons for the set-off. Contractor may submit a Change Proposal contesting the set-off.

C. No payment will be made for Work authorized by a Work Change Directive until the Work Change Directive is incorporated into a Change Order unless arrangements or interim payments have been included in the Work Change Directive. Payment can be included in an Application for Payment when the Change Order is approved.

D. The Owner is to pay the amount of payment recommended by the Construction Manager within 30 days after receipt of the Application for Payment and accompanying documentation from the Construction Manager.

E. Contractor certifies that all Work, including materials, covered by each Application for Payment have been completed or delivered and stored in accordance with the Contract Documents, that all amounts have been paid for Work, materials, and equipment for which previous payment has been made by the Owner, and that the current payment amount shown in this Application for Payment is due.

15.02 Contractor's Warranty of Title

A. Contractor warrants and guarantees that title to the Work, materials, and equipment furnished under the Contract is to pass to Owner free and clear of Liens, title defects, and patent, licensing, copyright, or royalty obligations no later than 7 days after the time of payment by Owner of the Application for Payment which includes these items.

15.03 Substantial Completion

A. Notify Construction Manager when the Work or portion of the Work to be accepted under Paragraph 15.04 is substantially complete and request a Certificate of Substantial Completion.

B. OPT is to inspect the Work after Contractor's notification to determine if the Work is substantially complete. Construction Manager is to either issue the Certificate of Substantial Completion which sets the date of Substantial Completion or notify Contractor of the reasons the Project is not considered to be substantially complete.

C. The OPT and Contractor are to meet to discuss Owner's use or occupancy of the Work following Substantial Completion. Items to be discussed at this meeting include:

1. Review of insurance policies with respect to the end of the Contractor's coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner;

2. Owner's assumption of responsibility for security, operation, protection of the Work, maintenance, and utilities upon Owner's use or occupancy of the Work;

3. Contractor's obligations for operations and maintenance during performance and acceptance testing;

4. Contractor's access to the Site to complete punch list items; and

5. Procedures for correction of Defective Work during the one-year correction period.

15.04 Partial Utilization

A. Owner may use or occupy substantially completed parts of the Work which are specifically identified in the Contract Documents, or which OPT and Contractor agree constitutes a separately functioning and usable part of the Work prior to Substantial Completion of the Work. Owner must be able to use that part of the Work for its intended purpose without significant interference with Contractor's performance of the remainder of the Work. Contractor and OPT are to follow the procedures of Paragraph 15.03 for this part of the Work.

B. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Article 6.

15.05 Final Inspection

A. OPT is to make a final inspection upon notice from Contractor that the entire Work or portion to be accepted under Paragraph 15.04 is complete. Construction Manager is to notify Contractor of Work determined to be incomplete or Defective. Immediately take corrective measures to complete the Work and correct Defective Work.

B. Notify Construction Manager when the entire Project and ready for Final Payment under Paragraph 15.06 and request a Certificate of Final Completion.

C. OPT is to inspect the Work after Contractor's notification to determine if the Project is complete. Construction Manager is to either issue the Certificate of Final Completion which sets the date of Final Completion or notify Contractor of the reasons the Project is not considered to be complete.

15.06 Final Payment

A. Make application for final payment after completing required corrections identified during the final inspection and delivering items and documents required by the Contract Documents. Provide the following with the final Application for Payment:

1. Consent of Surety to Final Payment acknowledging unsettled disputes; or

2. Affidavit of Payment of Debts and Claims or Affidavit of Release of Liens or furnish receipts or releases from Subcontractors and Suppliers when a payment bond is not required.

B. Construction Manager is to either recommend payment of the final Application for Payment to Owner if OPT is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled or notify the Contractor of the OPT's reasons for not recommending final payment.

C. The Work is complete, subject to surviving obligations, when it is ready for final payment as established by the Construction Manager's recommendation of payment of the final Application for Payment to Owner and the issuance of a Certificate of Final Completion.

D. The Owner is to pay the amount of final payment recommended by the Construction Manager within 30 days after receipt of the final Application for Payment and accompanying documentation from the Construction Manager; unless additional time is required for approval of a governing board or entity. Payment will be within 30 days of approval by the governing board or entity.

15.07 Waiver of Claims

A. The making of final payment does not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from:

1. Unsettled Liens or claims for non-payment;

2. Defective Work appearing after final inspection pursuant to Paragraph 15.05;

3. Contractor's failure to comply with the terms of special guarantees specified in the Contract Documents;

4. Outstanding Claims or express reservation of rights by Owner; or

5. Contractor's continuing obligations under the Contract Documents.

B. Contractor waives claims and rights against Owner by accepting final payment except for those Claims made in accordance with the provisions of Article 17 and specifically noted in the Certificate of Final Completion.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 Owner May Suspend Work

A. Owner may suspend the Work or a portion of the Work for a period of not more than 90 consecutive days, at any time and without cause, by notice to Contractor. This notice fixes the date on which Contractor is to resume Work. Contractor is entitled to adjustments in the Contract Price and Contract Times directly attributable to this suspension. Submit a Change Proposal seeking an adjustment no later than 30 days after the date fixed for resumption of Work.

16.02 Owner May Terminate for Cause

A. The occurrence of one or more of the following events constitutes a default by Contractor and justifies termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents, including failure to supply adequate skilled workers or suitable materials or equipment;

2. Failure to adhere to the Progress Schedule;

3. Failure of the Contractor to provide a satisfactory replacement bond or insurance in the event either is lost or canceled;

4. Failure of Contractor to maintain financial solvency to adequately complete the Project as indicated by one or more of the following:
    a. A petition of bankruptcy is filed by or against Contractor,
    b. Contractor is adjudged as bankrupt or insolvent,
    c. Contractor or surety makes a general assignment for the benefit of creditors,
    d. A receiver is appointed for the benefit of Contractor's creditors, or
    e. A receiver is appointed because Contractor's insolvency;
5. Contractor's disregard of Laws or Regulations of public bodies having jurisdiction; or
6. Contractor's repeated disregard of the authority of OPT.

B. Contractor and surety must provide adequate assurance of future performance in accordance with the Contract Documents that is satisfactory to Owner if Contractor is believed to be in financial distress due to the existence of one or more of the indicators listed in Paragraph 16.02.A.4. Owner may terminate this Contract if Contractor and surety fail to provide adequate documentation satisfactory to Owner within 10 days of Construction Manager's request for this information.

C. Owner may declare Contractor to be in default, give notice to Contractor and surety that the Contract is terminated, and enforce the rights available to Owner under the performance bond after giving Contractor and surety 10 days' notice that one or more of the events identified in Paragraph 16.02.A has occurred.

D. Owner may exclude Contractor from the Site, take possession of the Work, incorporate the materials and equipment stored and complete the Work as Owner may deem expedient if Owner has terminated the Contract for cause.

E. Owner may elect not to proceed with termination of the Contract under this Paragraph 16.02 if Contractor begins to cure the cause for termination within 7 days of receipt of notice of intent to terminate.

F. Contractor is not entitled to receive further payments until the Work is completed if Owner proceeds as provided in this Paragraph 16.02. The amount of the Contract Price remaining is to be paid to the Contractor if the unpaid balance exceeds the cost to complete the Work. This cost to complete the Work may include related claims, costs, losses, damages, and the fees and charges of engineers, architects, attorneys, and other professionals retained by Owner. Pay the difference to Owner if the cost to complete the Work including related claims, costs, losses, and damages exceeds the unpaid balance of the Contract Price. Claims, costs, losses, and damages incurred by Owner are to be reviewed as to their reasonableness and incorporated in a Change Order by Construction Manager. Owner is not required to obtain the lowest price for the Work performed when exercising its rights or remedies under this Paragraph 16.02.

G. Termination does not affect the rights or remedies of Owner against Contractor or against surety under the payment bond or performance bond. Owner does not release Contractor from liability by paying or retaining money due Contractor.

16.03 Owner May Terminate for Convenience

A. Owner may terminate the Contract without cause after giving 7 days' notice to Contractor of the effective date of termination. Contractor is to be paid for the following if Owner terminates for convenience:

1. Work completed in accordance with the Contract Documents prior to the effective date of termination;

2. Actual costs sustained prior to the effective date of termination for Work in progress, plus a fair and reasonable amount for overhead and profit; fee calculated in accordance with Paragraph 13.01; and

3. Reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

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

16.04 Contractor May Stop Work or Terminate

A. Contractor may terminate the Contract and issue a Change Proposal requesting payment from Owner on the same terms as provided in Paragraph 16.03 after 10 days' notice to Construction Manager provided that, through no act or fault of Contractor:

1. The Work is suspended for more than 90 consecutive days by Owner;

2. Construction Manager fails to act on an Application for Payment within 30 days after it is submitted; or

3. Owner fails to pay Contractor sums determined to be due, other than the final payment, within 30 days after payment is recommended by Construction Manager; and

4. OPT does not remedy this suspension or failure within 10 days after receipt of the notice.

B. Contractor may stop Work, without prejudice to other rights or remedies in lieu of terminating the Contract if Construction Manager has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed to pay Contractor within 30 days after payment is recommended by Construction Manager. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times for damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 Methods and Procedures

A. The Owner or Contractor may appeal a Claim, approved or denied in part or in full, by:

1. Electing to invoke the dispute resolution process if one is provided for in the Supplementary Conditions;

2. Agreeing with the other party to submit the dispute to a dispute resolution process; or

3. Notifying the other party of the intent to submit the dispute to a court of competent jurisdiction if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to.

ARTICLE 18 – MISCELLANEOUS

18.01 Computation of Times

A. Exclude the first day and include the last day when determining dates for a period referred to in the Contract Documents by days. The last day of this period is to be omitted from the determination if it falls on a Saturday, Sunday, or a legal holiday.

B. All references and conditions for a calendar day contract in the Contract Documents apply for a fixed date contract. A fixed date contract is one in which the calendar dates for reaching Substantial Completion and/or Final Completion are specified in lieu of identifying the number of calendar days involved.

18.02 Independent Contractor

A. Contractor is to perform its duties under this Contract as an independent contractor. The Contractor's Team and their personnel are not considered to be employees or agents of the Owner. Nothing in this Agreement is to be interpreted as granting Contractor's Team the right or authority to make commitments for the Owner. This Agreement does not constitute or create a joint venture, partnership, or formal business organization of any kind.

18.03 Cumulative Remedies

A. The duties and obligations imposed by these General Conditions and the rights and remedies available to the Owner or Contractor by these General Conditions are in addition to, and are not a limitation of, the rights and remedies which are otherwise imposed or available by:

1. Laws or Regulations;

2. Special warranties or guarantees; or

3. Other provisions of the Contract Documents.

B. The provisions of this Paragraph 18.03 are as effective as if repeated specifically in the Contract Documents regarding each duty, obligation, right, and remedy to which they apply.

18.04 Limitation of Damages

A. Owner's Indemnitees are not liable to Contractor for claims, costs, losses, or damages sustained by Contractor's Team associated with other projects or anticipated projects.

18.05 No Waiver

A. The failure of Owner or Contractor to enforce any provision of this Contract does not constitute a waiver of that provision, affect the enforceability of that provision, or the enforceability of the remainder of this Contract.

18.06 Severability

A. If a court of competent jurisdiction renders a part of this Contract invalid or unenforceable, that part is to be severed and the remainder of this Contract continues in full force.

18.07 Survival of Obligations

A. Representations, indemnifications, warranties, guarantees, and continuing obligations required by the Contract Documents survive completion and acceptance of the Work or termination of the Contract.

18.08 No Third-Party Beneficiaries

A. Nothing in this Contract can be construed to create rights in any entity other than the Owner and Contractor. Neither the Owner nor Contractor intends to create third-party beneficiaries by entering into this Contract.

18.09 Successors and Assigns

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

18.10 Assignment of Contract

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

18.11 No Waiver of Sovereign Immunity

A. The Owner has not waived its sovereign immunity by entering into and performing its obligations under this Contract.

18.12 Controlling Law

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

B. Venue for legal proceedings lies exclusively in Tarrant County.

END OF SECTION

00 73 00 SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement Section 00 72 00 “General Conditions.” The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below.

The paragraph numbers used in the Supplementary Conditions correspond to the General Condition paragraphs they modify with the prefix "SC" added—for example, “Paragraph SC-4.05.” modifies General Conditions Paragraph 4.05.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

SC-1.01 Defined Terms

A. The Owner’s Project Team as defined in the Paragraph 1.01.A.43 of the General Conditions consists of the following organizations:

1. City of Arlington, Texas
   Department of Water Utilities
   P.O. Box 90231
   Arlington, Texas 76004-3231

2. Arcadis U.S., Inc.
   630 Plaza Drive, Suite 200
   Highlands Ranch, CO 80129

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.02 Copies of Documents

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

“A. Owner will furnish 3 printed copies of the Contract Documents (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.”

B. Supplement Paragraph 2.04 of the General Conditions by adding the following paragraph:

“G. Requests by Contractor for Electronic Documents in Other Formats:

1. Release of any Electronic Document versions of the Project documents in formats other than those identified in Paragraph 2.04.F will be at the discretion of the OPT.

2. To the extent determined by OPT, release of Electronic Documents versions of Project documents and other Project information requested by Contractor (“Request”) in formats other than those identified in Paragraph 2.04.F will be

subject to the provisions of the Owner's response to the Request, and to the following conditions:

a. The content included in the Electronic Documents covered by the Request was prepared by Design Professional as an internal working document solely for Design Professional's purposes, and is being provided to Contractor on an "AS IS" basis without any warranties of any kind, including, any implied warranties of fitness for any purpose. As such, Contractor is advised and acknowledges that the content may not be suitable for Contractor's application or may require substantial modification and independent verification by Contractor. The content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other devices that may affect subsequent reuse.

b. Electronic Documents containing text, graphics, metadata, or other types of data that are provided by Design Professional to Contractor under the Request are only for convenience of Contractor. Any conclusion or information obtained or derived from such data will be at the Contractor's sole risk and the Contractor waives any claims against Design Professional or Owner arising from use of data in Electronic Documents covered by the Request.

c. **CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER AND DESIGN PROFESSIONAL AND THEIR SUBCONSULTANTS FROM ALL CLAIMS, DAMAGES, LOSSES, AND EXPENSES, INCLUDING ATTORNEYS' FEES AND DEFENSE COSTS ARISING OUT OF OR RESULTING FROM CONTRACTOR'S USE, ADAPTATION, OR DISTRIBUTION OF ANY ELECTRONIC DOCUMENTS PROVIDED UNDER THE REQUEST.**

d. Contractor agrees not to sell, copy, transfer, forward, give away or otherwise distribute this information (in source or modified file format) to any third party without the direct written authorization of Design Professional, unless such distribution is specifically identified in the Request and is limited to Contractor's subcontractors. Contractor warrants that subsequent use by Contractor's subcontractors complies with all terms of the Contract Documents and Owner's response to Request.

3. In the event that Owner elects to provide or directs the Design Professional to provide to Contractor any Contractor-requested Electronic Document versions of Project information that is not explicitly identified in the Contract Documents as being available to Contractor, the Owner shall be reimbursed by Contractor on an hourly basis for any costs necessary to create or otherwise prepare the data in a manner deemed appropriate by Design Professional at the rates set for in Article 15."

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.03 Delays in Contractor's Progress

A. Amend Paragraph 4.03.D by adding the following subparagraphs:

"1. Abnormal Weather Conditions:

a. If "abnormal weather conditions" are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following: 1) that weather conditions were abnormal for the period of time in which the delay occurred, 2) that such weather conditions could not have been reasonably anticipated, and 3) that such weather conditions had an adverse effect on the Work as scheduled.

b. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with the following:

1) Every workday on which one or more of the following conditions exist will be considered a "bad weather day":

a) Total precipitation occurring between 7:00 p.m. on the preceding day (regardless of whether such preceding day is a workday) through 7:00 p.m. on the workday in question equals or exceeds 0.25 inches of precipitation.

2) Determination of actual bad weather days during performance of the Work will be based on the weather records measured and recorded by the National Oceanic and Atmospheric Administration (NOAA) weather monitoring station at Dallas Fort Worth International Airport.

3) Every bad weather day exceeding the number of foreseeable bad weather days established in Paragraph b) will be considered as "abnormal weather conditions." The existence of abnormal weather conditions will not relieve Contractor of the obligation to demonstrate and document that delays caused by abnormal weather are specific to the planned work activities or that such activities thus delayed were on Contractor's then-current Progress Schedule's critical path for the Project.

a) Incorporate "bad weather days" into the schedule for construction. Schedule construction so that the Work will be completed within the Contract Times assuming that these "bad weather days" will occur. Incorporate residual impacts following "bad weather days" such as limited access to and within the Site, inability to work due to wet or muddy Site conditions, delays in delivery of equipment and materials and other impacts related to precipitation days when developing the schedule for Construction. Include all costs associated with these precipitation days and residual impacts in the Contract Price.

b) A total of 15 "bad weather days" per calendar year has been set for this Project. An extension of time due to "bad weather days" will be considered only after 15 "bad weather days" per calendar year have been exceeded in a calendar year and the Construction Manager has

determined that a detrimental impact to the construction schedule resulted from the excessive rainfall. “Bad weather days” days are to be incorporated into the schedule as a line item and unused rain days will be considered float time which may be consumed by the Owner or Contractor in delay claims.”

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

SC-5.03 Subsurface and Physical Conditions

A. This Supplementary Condition identifies the reports and drawings referenced in Paragraph 5.03 of the General Conditions related to subsurface and physical conditions.

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

Report Title	Report Date	Technical Data
Geotechnical Investigation John F. Kubala Water Treatment Plant	October, 2019	Geotechnical Information

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

Drawing Title	Drawing Date	Technical Data
John F. Kubala WTP Expansion Project	2000	Record Drawings
John F. Kubala WTP Expansion II	2008	Record Drawings
Electrical Power Distribution Improvements and Back-up Power Modifications – John F. Kubala WTP	2018	Record Drawings
John F. Kubala WTP – West High Service Pump Station – Pump 3 Addition	2021	Conformed Drawings

3. Copies of reports and drawings may be downloaded from the project procurement website.

SC-5.06 Hazardous Environmental Conditions at Site

A. This Supplementary Condition identifies the reports and drawings referenced in Paragraph 5.06 of the General Conditions related to Hazardous Environmental Conditions at the Site.

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

Report Title	Report Date	Technical Data
No Reports		

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

Drawing Title	Drawing Date	Technical Data
No Drawings		

3. Copies of reports and drawings may be downloaded from the project procurement website.

ARTICLE 6 – BONDS AND INSURANCE

SC-6.01 Performance, Payment, and Other Bonds

A. Contractor is to notify Subcontractors and Suppliers that any request related to payment bond and payment information per Paragraph 6.01.B.3 of the General Conditions are to be sent to the Owner to the attention of:

Ashley Brown
Attention Second Floor Water Utilities
101 West Abram Street
Arlington, Texas 76010

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; FINAL COMPLETION

SC-15.01 Progress Payments

A. Compensation for services of OPT staff as specified in Paragraph 15.01 will be at the following rates:

Position	Hourly Rate
Principal in Charge	$260
Project Manager	$260
Project Engineer	$260
Construction Manager	$215
Resident Engineer	$215
Project Construction Manager	$215
Design Engineer	$201
Engineering Technician	$139
Clerk	$112

B. Expenses will be billed at the actual cost multiplied by 1.15.

SC-15.03 Substantial Completion

A. Treatment processes must be operational with all appurtenances, power, automation, labeling, etc. as specified.

END OF SECTION

00 73 16 INSURANCE REQUIREMENTS

ARTICLE 1 – GENERAL PROVISIONS

1.01 CONTRACTOR'S INSURANCE

A. Obtain and maintain insurance that complies with this Section with coverage amounts equal to or greater than the amounts specified in Article 2 or greater where required by Laws and Regulations.

B. Coverage is to remain in effect at least until the Work is complete and longer if expressly required elsewhere in this Contract, and when Contractor may be correcting, removing, or replacing Defective Work as a warranty or correction obligation, or returning to the Site to conduct other tasks arising from the Contract.

C. Coverage is to apply with respect to the performance of the Work, whether performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.

D. Obtain insurance from companies that are duly licensed or authorized in the state in which the Project is constructed to issue insurance policies for the required limits and coverages and that have an A.M. Best rating of A-VII or better.

E. Alternative forms of insurance coverage, including self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not acceptable to meet the insurance requirements of this Contract.

F. Owner will not purchase or maintain insurance to protect the interest of the Contractor, Subcontractors, or others in the Work. Owner does not represent that the insurance coverage and limits established in this Contract are adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary and including the cost of this insurance in the offered Contract Price.

G. Contractor is fully responsible for all losses arising out of, resulting from or connected with operations under this Contract whether or not these losses are covered by insurance. The acceptance of evidence of insurance by the OPT, or others listed as an additional insured, that does not comply with the Contract requirements does not release the Contractor from the requirement to comply with Contract requirements.

H. The required insurance and insurance limits do not limit the Contractor's liability under the indemnities granted to Owner's Indemnitees in the Contract Documents.

I. Do not perform any Work on the Project unless the required insurance policies are in effect. Owner may exclude the Contractor from the Site and exercise Owner's termination rights under the General Conditions if Contractor fails to obtain or maintain the required insurance.

J. Policies must provide notice before cancellation, non-renewal or any material change in the policy's terms and conditions as described in Paragraph 1.04.D. Contractor is to notify Owner and the additional insured of any notice received within 3 days of receipt of a notice

by Contractor. Contractor is to cease all Work covered by cancelled or non-renewed insurance if suitable coverage is not in place in time to prevent a lapse in coverage. Contractor is solely responsible for any delays associated with lapsed coverage.

K. Owner may elect, but is in no way obligated, to obtain equivalent insurance to protect Owner's interests without prejudice to any other right or remedy if the Contractor fails to obtain or maintain the required insurance. Owner may impose a reasonable set-off against payments to recover the cost of the insurance.

L. Owner's policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's policies to meet any of Contractor's obligations to the Owner, Design Professional, or third parties.

1.02 SUBCONTRACTOR OR SUPPLIER INSURANCE

A. Require Subcontractors to purchase and maintain workers' compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project. Include OPT as additional insureds on Subcontractor's policies in accordance with Paragraph 1.03.

B. Require Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

C. Contractor is liable for all losses that would have been covered by Subcontractor or Supplier insurance if Subcontractor or Supplier fails to provide coverage.

1.03 ADDITIONAL INSURED

A. The following are to be named as an additional insured on all insurance policies, except workers' compensation insurance, builder's risk insurance, and the Contractor's professional liability insurance:

1. City of Arlington, Texas
   Attn: Ashley Brown
   Department of Water Utilities
   P.O. Box 90231
   Arlington, Texas 76004-3231

2. Arcadis U.S., Inc.
   630 Plaza Drive, Suite 200
   Highlands Ranch, CO 80129

B. All insurance related notices are to be sent to the addresses listed above.

C. Notify the Owner and additional insured if the Contractor fails to purchase or maintain the insurance required by the Contract Documents.

D. All insurance policies must include a waiver of subrogation in favor of each additional insured.

E. Provide for an endorsement that the "other insurance" clause will not apply to the OPT where the OPT is an additional insured. Contractor's insurance is primary and non-contributory with respect to any insurance or self-insurance carried by the OPT for liability arising out of operations under this Contract.

1.04 EVIDENCE OF INSURANCE

A. Deliver evidence of insurance, in accordance with this Section, to the Owner with the signed Contract Documents to demonstrate that Contractor has obtained the policies, coverages, and endorsements required by the Contract.

1. Continue to provide evidence Contractor is maintaining the required insurance for the duration of the Contract Times and such extended periods as required by the Contract Documents.

2. Provide this evidence of insurance to Owner and each additional insured.

3. Contractor may block out (redact) any confidential premium or pricing information and wording specific to a project or jurisdiction in any policy or endorsement furnished under this paragraph not applicable to this Contract.

B. OPT's failure to demand evidence of insurance or verify the Contractor's full compliance with insurance requirements or failure to identify a deficiency in compliance from the evidence provided is not a waiver of the Contractor's obligation to obtain and maintain the insurance required by the Contract Documents

C. Provide evidence of insurance acceptable to the Owner with the executed Contract Documents. Provide the following as evidence of insurance:

1. Copy of insurance policies;

2. Certificates of insurance on an acceptable form;

3. Full disclosure of exclusions;

4. Declaration pages, riders, or endorsements to policies;

5. Documentation of deductibles;

6. List of named and additional insureds for each policy; and

7. Evidence that waivers of subrogation are provided on applicable policies.

D. Provide evidence of a requirement in the policy that at least 30 days' notice will be given before cancellation, and at least 10 days' notice of non-renewal or any material change in the policy's terms and conditions including:

1. Type of coverage provided;

2. Riders or endorsements to policies;

3. Policy limits of coverage;

4. Change in deductible amount;

5. Status of named or additional insured; or

6. Waivers of subrogation.

E. Certificates of Insurance:

1. Submit certificates of insurance meeting the applicable requirements of the applicable state department of insurance. No requirement of this Contract may be interpreted as requiring the issuance of a certificate of insurance on a form that has not first been filed with and/or approved by the applicable state department of insurance.

2. Include the name of the Project in the description of operations box on the certificate of insurance, and the name of each additional insured.

F. Continuing Evidence of Coverage:

1. Provide updated, revised, or new evidence of insurance prior to the expiration of existing policies. A certificate of insurance on an Acord form, or other State approved form, is acceptable as evidence of renewal of insurance policies, provided no changes are made in the policy originally provided with signed Contract Documents.

2. Provide evidence of continuation of insurance coverage at final payment and for the following 3 years.

G. Submit Evidence of Insurance to:

City of Arlington
Department of Water Utilities
Attention: Ashley Brown
P.O. Box 90231
Arlington, Texas 76004-3231

ARTICLE 2 – INSURANCE COVERAGE AMOUNTS AND POLICY REQUIREMENTS

2.01 CONTRACTOR'S INSURANCE

A. Workers' Compensation and Employer's Liability Insurance:

1. Purchase and maintain workers' compensation and employer's liability insurance, including, as applicable, United States Longshoreman and Harbor Workers' Compensation Act, Jones Act, stop-gap employer's liability coverage for monopolistic states, and foreign voluntary workers' compensation, including off-site operations.

2. Provide the following coverage with not less than the minimum limits indicated:

Workers' Compensation and Related Insurance	Policy Limits
Workers' Compensation	Statutory Limit
Employers' Liability	
Each Occurrence	$1,000,000.00
Disease – Each Employee	$1,000,000.00
Disease - Policy Limit	$1,000,000.00

B. Commercial General Liability

1. Purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:

a. Damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

b. Damages insured by reasonably available personal injury liability coverage; and

c. Damages because of injury to or destruction of tangible property wherever located, including loss of use resulting from the damage.

2. Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form).

a. Provide additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). Equivalent endorsements may be used if Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available.

b. Provide ISO Endorsement CG 20 32 07 04 "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent for Design Professional additional insured.

3. Provide the following coverages and endorsements:

   a. Products and completed operations coverage.

      1) Maintain coverage for 3 years after final payment.

      2) Provide Owner and each other additional insured evidence of continuation of such insurance at final payment and for 3 years thereafter.

   b. Blanket contractual liability coverage, including coverage of Contractor's contractual indemnity obligations in the General Conditions.

   c. Severability of interests and no insured-versus-insured or cross-liability exclusions.

   d. Underground, explosion, and collapse coverage.

   e. Personal injury coverage.

4. The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:

   a. Modifications of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).

   b. Exclusion for water intrusion or water damage.

   c. Provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.

   d. Exclusion of coverage relating to earth subsidence or movement.

   e. Exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than workers' compensation).

   f. Limitations or exclusions based on the nature of Contractor's work.

   g. Professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.

5. Provide the following coverage with not less than the minimum limits indicated:

Commercial General Liability Insurance	Policy Limits
Per Occurrence	$1,000,000.00
Aggregate	$2,000,000.00
No standard coverages are to be excluded by endorsement. XCU and contractual liability are not to be excluded	

C. Automobile Liability:

1. Purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis. Coverage can be provided through individual limits for bodily injury and for property damage or a combined single limit covering both bodily injury and property damage.

2. Provide the following coverage with not less than the minimum limits indicated:

Commercial Automobile Liability Insurance	Policy Limits
Combined Single Limit	$1,000,000.00
Any Auto, including hired, and non-owned autos	

D. Umbrella or Excess Liability:

1. Purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the Paragraphs A through C above. The coverage afforded must be at least as broad as that of each underlying policy.

2. Contractor may meet the policy limits specified for employer's liability, commercial general liability, and automobile liability through the primary policies alone, or through combinations of the primary insurance policy's policy limits and partial attribution of the policy limits of an umbrella or excess liability policy that is at least as broad in coverage as that of the underlying policy. If such umbrella or excess liability policy was required under this Contract, at a specified minimum policy limit, such umbrella or excess policy must retain a minimum limit of $**[specify amount]** after accounting for partial attribution of its limits to underlying policies, as allowed above.

3. Provide the following coverage with not less than the minimum limits indicated:

Umbrella or Excess Liability Insurance	Policy Limits
Each Occurrence	$2,000,000.00
Following Form and Drop-down Provisions Included	

E. Contractor's Pollution Liability Insurance:

1. Purchase and maintain a policy covering third-party injury and property damage, including cleanup costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance must be maintained for no less than 3 years after Final Completion.

2. Provide the following coverage with not less than the minimum limits indicated:

Contractor's Pollution Liability Insurance	Policy Limits
Each Occurrence	$1,000,000
General Aggregate	$2,000,000

2.02 INSTALLATION FLOATER

A. Provide and maintain installation floater insurance on a broad form or "all risk" policy providing coverage for materials, supplies, machinery, fixtures, and equipment that will be

incorporated into the Work ("Covered Property"). Coverage under the Contractor's installation floater will include loss from covered "all risk" causes (perils) to Covered Property:

1. of the Contractor, and Covered Property of others that is in Contractor's care, custody, and control;
2. while in transit to the Site, including while at temporary storage sites;
3. while at the Site awaiting and during installation, erection, and testing;
4. continuing at least until the installation or erection of the Covered Property is completed, and the Work into which it is incorporated is accepted by Owner.

B. The installation floater coverage cannot be contingent on an external cause or risk, or limited to property for which the Contractor is legally liable.

C. The installation floater coverage will be in an amount sufficient to protect Contractor's interest in the Covered Property. The Contractor will be solely responsible for any deductible carried under this coverage.

D. This policy will include a waiver of subrogation applicable to Owner, Contractor, Design Professional, all Subcontractors, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them.

END OF SECTION

00 73 17 TEXAS WORKERS' COMPENSATION INSURANCE

ARTICLE 1 – REQUIRED NOTICE

1.01 Workers' Compensation Insurance Coverage

A. Definitions:

1. Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the division, or a coverage agreement (DWC Form 81, DWC Form 82, DWC Form 83, or DWC Form 84), showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the project.

2. Duration of the project - includes the time from the beginning of the work on the project until the contractor's/person's work on the project has been completed and accepted by the governmental entity.

3. Persons providing services on the project ("subcontractor" in §406.096) - includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the project, regardless of whether that person contracted directly with the contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project. "Services" does not include activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

B. The contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all employees of the contractor providing services on the project, for the duration of the project.

C. The contractor must provide a certificate of coverage to the governmental entity prior to being awarded the contract.

D. If the coverage period shown on the contractor's current certificate of coverage ends during the duration of the project, the contractor must, prior to the end of the coverage period, file a new certificate of coverage with the governmental entity showing that coverage has been extended.

E. The contractor shall obtain from each person providing services on a project, and provide to the governmental entity:

1. a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on the project; and

2. no later than 7 days after receipt by the contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

F. The contractor shall retain all required certificates of coverage for the duration of the project and for one year thereafter.

G. The contractor shall notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.

H. The contractor shall post on each project site a notice, in the text, form and manner prescribed by the Texas Department of Insurance, Division of Workers' Compensation, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.

I. The contractor shall contractually require each person with whom it contracts to provide services on a project, to:

1. provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all of its employees providing services on the project, for the duration of the project;

2. provide to the contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;

3. provide the contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

4. obtain from each other person with whom it contracts, and provide to the contractor:

    a. a certificate of coverage, prior to the other person beginning work on the project; and

    b. a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

5. retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

6. notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

7. contractually require each person with whom it contracts, to perform as required by paragraphs 1 - 7, with the certificates of coverage to be provided to the person for whom they are providing services.

J. By signing this contract or providing or causing to be provided a certificate of coverage, the contractor is representing to the governmental entity that all employees of the contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the

division. Providing false or misleading information may subject the contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

K. The contractor's failure to comply with any of these provisions is a breach of contract by the contractor which entitles the governmental entity to declare the contract void if the contractor does not remedy the breach within ten days after receipt of notice of breach from the governmental entity.

END OF SECTION

00 73 39 MINORITY/WOMEN BUSINESS ENTERPRISE PARTICIPATION PROGRAM

ARTICLE 1 – OWNER'S MINORITY/WOMEN BUSINESS ENTERPRISE PARTICIPATION PROGRAM

1.01 POLICY

A. Contractor is encouraged to use, if applicable, qualified subcontractors, suppliers, and firms where at least fifty-one percent (51%) of the ownership of such subcontractor, supplier or firm is vested in racial or ethnic minorities or women. In the selection of subcontractors, suppliers or other persons in organizations proposed for work on this contract, the Contractor agrees to consider this policy and to use reasonable and best effort to select and employ such company and persons for work on this contract. The successful Contractor will be required to submit cost information towards MWBE firms. The information submitted shall include the Contractors and any other subcontractors performing work as part of this contract. The successful Contractor will be required to submit anticipated dollar amounts towards these enterprises (if applicable) at time contract is awarded and actual dollar amounts spent with the monthly pay estimate. City will provide all applicable forms. Submitted forms shall be accompanied by copy of certification(s) for Contractor and all applicable subcontractors. It shall be incumbent upon the successful Contractor to ensure submitted certification(s) are up to date, including for all applicable subcontractors

1.02 REQUIRED DOCUMENTATION

A. Provide documentation of MWBE Participation each month using the form provided in Section 00 43 16 "Prime, Subs & Minority/Women Business Enterprise (MWBE) Report.

END OF SECTION

00 73 43 WAGE RATE REQUIREMENTS

ARTICLE 1 – PREVAILING WAGE RATES

1.01 PAYMENT OF PREVAILING WAGE RATES

A. Contractor and any Subcontractors employed on this Project must pay not less than the rates established by the Owner as required by Texas Government Code Chapter 2258.

1.02 RECORDS

A. In accordance with Tex. Gov't Code §2258.024, the Contractor and its Subcontractors, if any, shall keep a record showing:

1. The name and occupation of each worker employed by the Contractor or Subcontractor in the construction of the Work; and

2. The actual per diem wages paid to each worker.

B. The record shall be open at all reasonable hours to inspection by the officers and agents of the Owner.

1.03 LIABILITY; PENALTY; CRIMINAL OFFENSE

A. Tex. Gov't Code §2258.003 – Liability: An officer, agent, or employee of the Owner is not liable in a civil action for any act or omission implementing or enforcing Chapter 2258 unless the action was made in bad faith.

B. Tex. Gov't Code §2258.023(b) – Penalty: Any Contractor or Subcontractor who violates the requirements of Chapter 2258, shall pay to the Owner, on whose behalf the Contract is made, $60 for each worker employed or each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the Contract.

C. Tex. Gov't Code §2258.058 – Criminal Offense:

1. An officer, agent, or representative of the Owner commits an offense if the person willfully violates or does not comply with a provision of Chapter 2258.

2. Any Contractor or Subcontractor, or an agent or representative of the Contractor or Subcontractor, commits an offense if the person violates Tex. Gov't Code §2258.024.

3. An offense is punishable by:

a. A fine not to exceed $500;

b. Confinement in jail for a term not to exceed 6 months; or

c. Both a fine and confinement.

1.04 MINIMUM WAGE RATES

A. The minimum wage rates for various labor classifications as established by the Owner are as shown in Section 00 73 46 "Wage Determination Schedule."

END OF SECTION

00 73 46 WAGE DETERMINATION SCHEDULE

The City of Arlington has adopted the following Prevailing Wage Rates for this project:

General Decision Number: TX20200026 01/03/2020

Superseded General Decision Number: TX20190026

State: Texas

Construction Type: Heavy

Counties: Johnson, Parker and Tarrant Counties in Texas.

Heavy Construction Projects (Including Water and Sewer Lines)

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number: 0

Publication Date: 01/03/2020

* PLUM0146-002 05/01/2019

Classification	Rates	Fringes
* PLUM0146-002 05/01/2019		
Plumber/Pipefitter	$31.68	9.50
SUTX1990-041 06/01/1990		
Carpenter	$10.40	3.64
Concrete Finisher	$9.81	
Electrician	$13.26	
Form Setter	$7.86	
Laborers:		
Common	$7.25	
Utility	$8.09	
Painter	$10.89	
Pipelayer	$8.43	

Classification	Rates	Fringes
Power Equipment Operators:		
Backhoe	$11.89	3.30
Bulldozer	$10.76	
Crane	$13.16	3.30
Front End Loader	$10.54	
Mechanic	$10.93	
Scraper	$10.00	
Reinforcing Steel Setter	$10.64	
Truck Driver	$7.34	
Welders - Receive rate prescribed for craft performing operation to which welding is incidental.		

END OF SECTION

01 11 00 SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Construct Work as described in the Contract Documents.

1. Provide the materials, equipment, and incidentals required to make the Project completely and fully operable.

2. Provide the labor, equipment, tools, and consumable supplies required for a complete Project.

3. Provide the civil, architectural, structural, mechanical, electrical, instrumentation, and all other Work required for a complete and operable Project.

4. Test and place the completed Project in operation.

5. Provide the special tools, spare parts, lubricants, supplies, or other materials as indicated in the Contract Documents for the operation and maintenance of the Project.

6. The Contract Documents do not indicate or describe all Work required to complete the Project. Additional details required for the correct installation of selected products are to be provided by the Contractor and coordinated with the Construction Manager.

B. Owner may pre-select or pre-purchase goods for this Project per Section 01 64 00 "Owner-Furnished Goods and Special Services." Install these goods and coordinate the performance of specified special services.

1.02 DESCRIPTION OF WORK

A. Work is described in general, non-inclusive terms as:

1. The Work consists of the purchase and installation of two 5 MGD pumps and construction a new pump pad can located east of the current West High Service Pump Station along with the all the associated mechanical, electrical and instrumentation requirements.

1.03 WORK UNDER OTHER CONTRACTS

A. The following items of work are not included in this Contract, but may impact construction scheduling, testing, and startup:

Owner	Description
City of Arlington	JKWTP Chemical Improvements project
City of Arlington	JKWTP Backwash Modification project
City of Arlington	JKWTP Lab and Maintenance Building project
City of Arlington	JKWTP WHSPS Pump 3 Addition

B. Bring any discrepancies in the list to the attention of the Construction Manager. It will be deemed that the Contractor included the more expensive listing in the Contract Price if the

Contractor fails to bring any discrepancies to the attention of the Construction Manager prior to executing the Agreement.

C. Completion of the Work described in this Contract may impact the construction and testing of the items listed above.

1. Coordinate construction activities through the Construction Manager.

2. Pay claims for damages which result from the late completion of the Project or any specified Milestones.

1.04 WORK BY OWNER

A. The Owner has no knowledge of work, other than the Work included in this Contract that may impact construction scheduling, testing, and startup.

B. Bring any discrepancies between the projects listed above and those specified elsewhere in the Contract Documents to the attention of the Construction Manager. It will be deemed that the Contractor included the more expensive listing in the Contract Price if the Contractor fails to bring any discrepancies to the attention of the Construction Manager prior to executing the Agreement.

C. Completion of the Work described in this Contract may impact the construction and testing of the items listed above.

1. Coordinate construction activities through the Construction Manager.

2. Pay claims for damages which result from the late completion of the Project or any specified Milestones.

D. Owner will provide normal operation and maintenance of the existing facilities during construction, unless otherwise stated.

1.05 CONSTRUCTION OF UTILITIES

A. Existing utilities will be used for this Project. Coordinate with others performing Work associated with this Project.

B. Power and Electrical Services:

1. Provide permanent power connections for the Site through the power utility unless indicated otherwise in the Contract Documents.

2. Pay for permits and for providing permanent power.

3. Coordinate and cooperate with others performing this Work.

4. Provide conduit, conductors, pull boxes, manholes, and other appurtenances for the installation of power cable between the property line and the transformer and between the transformer and the main power switch unless the Contract Documents indicate otherwise.

5. Test conductors in accordance with the Specifications and requirements of the power utility and coordinate with the power utility to energize the system when ready.

6. Pay for temporary power including construction cost, meter connection, fees, and permits.

7. Contractor may use the permanent power source in lieu of temporary power source when permanent power is available at the Site.
    a. Notify Construction Manager and Owner of intent to use the permanent power source.
    b. Arrange with the power utility and pay the charges for connections and monthly charges for use of this power.
8. Pay for the power consumed until the Project has been accepted as Substantially Complete unless noted otherwise.

C. Telephone Services:
1. Provide permanent telephone service for the Site through the telephone utility.
2. Pay for providing permanent telephone service.
3. Coordinate and cooperate with others performing this Work.
4. Test all cable and connections in accordance with Specifications and telephone utility requirements and coordinate with the telephone utility to ring out all lines on the system when ready.
5. Pay for temporary service including construction cost, telephones, internet and equipment, connection fees, and permit.
6. Contractor may use the permanent telephone lines in lieu of temporary lines when permanent lines are available at the Site.
7. Notify Construction Manager and Owner of intent to use the permanent telephone system.
8. Arrange with the telephone utility and pay the charges for connections and monthly charges for use of this service.
9. Pay for the service until the Project has been accepted as Substantially Complete.

1.06 NOMINATED SUBCONTRACTOR

A. Owner has or will select a Subcontractor for furnishing, installing, and testing the following products:

Description	Supplier	Specification
PLC Programming (PSCI)	Programming by others	NA

B. These Subcontractors will be designated as “Nominated Subcontractors.” Agreements for services are described in the referenced appendices. Obtain clarification from the Construction Manager in the case of a disagreement between the above list and those specified elsewhere in the Contract Documents.

C. Assume responsibilities for Nominated Subcontractors’ products and installation as for those products selected and installed by the Contractor.

D. Coordinate Work performed by Nominated Subcontractors.

E. Provide labor, materials, equipment, tools, consumable supplies, and incidentals not specifically required by the subcontract required to provide a complete and operable Project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 15 00 CONSTRUCTION SITE SECURITY PROCEDURES

PART 1 - GENERAL

1.01 CONTRACTOR'S RESPONSIBILITIES

A. Initiate a site security program from the start of the project.

B. Prevent access by any individual who is not authorized to enter the Project Site.

C. Provide security for:

1. Existing facilities (operating or not);
2. Contractor's Team and OPT field office trailers and their contents;
3. Work in place;
4. Stored materials;
5. Contractor's equipment, tools, and materials.

D. Maintain a list of Emergency Contacts.

E. Provide a written Security Plan.

F. Provide background checks for all employees of Contractor and Subcontractor.

G. Implement and maintain a security identification system.

H. Maintain the security program throughout duration of the Contract.

I. Require personnel to follow and adhere to the established policy of entering, remaining, and exiting the Work Site. The Owner has the right to refuse access to the Project Site or request that a person or vehicle be removed from the Site if found violating any Project security rules.

J. The security measures described in this Section are minimum requirements. Provide additional security measures if site conditions and history warrant additional security measures.

1.02 DOCUMENTATION

A. Submit the following as Record Data

1. Security Plan
2. Emergency Contact Information
3. Current list of all contractor and subcontract employees to be provide access to the site. List are to be updated weekly

1.03 SECURITY PLAN

A. Submit the Security Plan as Record Data. Security Plan is to describe the implementation of the requirements of this Section.

1.04 EMERGENCY CONTACTS

A. Provide the PCM with a list of 24-hour emergency phone numbers for Contractor's personnel and emergency service providers other than those listed in Paragraph B. CM will provide an emergency contact list that include OPT emergency contacts. Contract list is to be updated each time a change is required by changes in contact personnel or contact information. Review list at each progress meeting.

B. Emergency Service Providers

1. The Site is located within the jurisdiction of the City of Arlington. Contact information is:

Emergency telephone: 911

Non-Emergency telephone: 817-274-4444

2. Fire protection and emergency medical services are provided by City of Arlington.

Emergency telephone: 911

Non-Emergency telephone: 817-459-5500

1.05 BACKGROUND CHECKS

A. Provide background checks for all Contractor and Subcontractor employees. Background checks are to be performed by an independent security agency approved by the Owner.

B. Do not allow any individual on Site who has a criminal history reflecting a felony conviction within the past 5 years.

C. Notify Owner and CM of the termination, change in criminal history or other change for any Contractor or Subcontractor employee that would make the individual ineligible to participate on the Project on-site. Notify security guards to prohibit access to the site without a security escort.

1.06 SECURITY IDENTIFICATION

A. Implement and maintain a security badge system for all Contractor and Subcontractor employees. Badge is to display the name of the employee, photo of the employee, name of employer and project name. Photo is to be a headshot without a head covering or glasses, other than those require to be worn for corrective vision. Employees are to carry security badges on their person at all time when on site.

B. Provide project specific decals for hardhats to identify those individuals that are authorized to work on site. Decals must be at least three inches in diameter and applied to the side or back of the hardhat to be readily visible.

C. Vehicles must display Contractor or Subcontractor company name or logo when onsite. Vehicles not bearing names or logos must display a vehicle pass attached to the rear-view mirror or on the driver's side dashboard at all time while on site.

1.07 JOB SITE ORIENTATION

A. Provide jobsite orientation training to all Contractor or Subcontractor employees working onsite. Maintain records which include signature of employees to acknowledge their participation in the orientation training.

B. Training is to include at least the following items:

1. Security procedures for access to the site;
2. Emergency and safety procedures;
3. Onsite Identification display procedures;
4. Provisions in Section 01 31 00 Project Management and Coordination
5. Identify work areas
6. Identify limited access areas for existing facilities
7. Site specific hazards;
8. Use of sanitation facilities and restrictions on use of Owner facilities; and
9. Requirements to maintain site.

PART 2 - EXECUTION

2.01 SECURITY SERVICES

A. Control entry to the Project Site.

1. Verify vehicle passes and personnel badges;
2. Maintain a list of authorized employee and visitors;
3. Monitor the passage of personnel, vehicles, materials, and equipment entering and leaving the Project Site;
4. Record the license plates of vehicles permitted to enter the Project Site construction area.
5. Report any unauthorized access to the Site to the Security Guards on duty and Owner immediately.
6. Direct emergency vehicles or equipment to the proper location.
7. Direct personnel, vehicles, materials, and equipment to the proper gate in the event a multiple gate system is implemented.
8. Direct traffic as requested by the Owner, including off-site traffic. Direct visitors to the proper offices of the Owner, Construction Manager and Contractor.

B. Site Security

1. Enforce parking area regulations and site speed limit, obtain the name/vehicle license number of violators, and report them to the Owner.
2. Monitor security of equipment and/or material temporarily stored along the access road or in the parking area.

3. Call Owner, Contractor and Construction Manager report a fire, hazardous material spill or medical emergency. Report the emergency to the appropriate emergency entity.
4. Notify Owner, Contractor and Construction Manager of all unusual activities or occurrences.
5. Assist in removing personnel denied access to the Project Site for violation of site regulations.

C. Reporting

1. Maintain daily security log. Security logs are to include gate activity and reports from patrols made during non-working hours.
2. Deliver the Security Log to the Construction Manager and Contractor at the end of each week. Enter all facts regarding the incident in a Security Log.
3. Notify the Owner, Contractor and Construction Manager immediately of any security violations.

END OF SECTION

01 23 10 ALTERNATES AND ALLOWANCES

PART 1 - GENERAL

1.01 SUMMARY

A. Alternates:

1. This Section describes each alternate by number and describes the basic changes to be incorporated into the Work when this alternate is made a part of the Work in the Agreement.
2. The Drawings and Specifications will outline the extent of Work to be included in the alternate Contract Price.
3. Coordinate related Work and modify surrounding Work as required to properly integrate the Work under each alternate and provide a complete and functional Project as required by the Contract Documents.
4. Alternate Bids or Proposals may be accepted or rejected at the option of the Owner.
5. Owner may incorporate these alternates in the Contract when executed or may issue a Change Order to incorporate these alternates within 120 days of the opening of Contractor's Bid or Proposal at the prices offered in the Contractor's Bid or Proposal, unless noted otherwise. A Request for a Change Proposal may be issued after 120 days or other designated time period to negotiate a new price for incorporating the Work into the Project.

B. Allowances:

1. Include the specified allowance amounts in the Contract Price.
2. The amount of each allowance includes:
    a. The cost of the product to the Contractor less any applicable trade discounts;
    b. Delivery to the Site; and
    c. Applicable taxes.
3. Include in the Contract Price all costs for:
    a. Handling at the Site, including unloading, uncrating, and storage per Section 01 31 00 "Project Management and Coordination."
    b. Cost for labor and equipment for installation and finishing.
    c. Cost for related products not specifically listed in the allowance required for installation, including consumable supplies and materials.
    d. All overhead, profit, and related costs.
4. Assist Owner in the selection of products.
    a. Identify qualified Suppliers.
    b. Obtain bids or proposals from qualified Suppliers.

c. Present available alternates to the Owner through the Construction Manager. Notify Construction Manager of:

1) Any objections to a particular Supplier or product.

2) Effect on the construction schedule anticipated by the selection of each option.

3) Cost of each option.

5. Upon selection of the product:

a. Purchase and install the product.

b. Contractor's responsibilities for products will be the same as for products selected by the Contractor.

6. Submit a Change Proposal per Section 01 26 00 "Change Management" to adjust the Contract Price if the net cost of the product is more or less than the specified amount.

a. Adjust the unit cost applied to the quantities installed per the method of payment described in Section 01 29 00 "Application for Payment Procedures" for products specified as Unit Price Work.

b. Do not perform Work until selection of alternate has been approved by the Owner.

c. Provide actual invoices for the materials.

1.02 DOCUMENTATION

A. Provide documents for materials furnished as part of each alternate in accordance with Section 01 33 00 "Document Management."

1.03 DESCRIPTION OF ALLOWANCES

A. Allowance D-01 – Owner's Contingency Allowance.

1. The Owner's Contingency Allowance will be used to pay the contractor for approved change proposals requiring a change in Contract Price per Section 01_26_00 Change Management.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 26 00 CHANGE MANAGEMENT

PART 1 - GENERAL

1.01 REQUESTS FOR CHANGE PROPOSAL

A. Construction Manager will initiate Modifications by issuing a Request for Change Proposal (RCP).

1. Construction Manager and Design Professional will prepare a description of proposed Modifications.

2. Construction Manager will issue the Request for Change Proposal form to Contractor. A number will be assigned to the Request for a Change Proposal when issued.

3. Return a Change Proposal in accordance with Paragraph 1.02 for evaluation by the OPT.

1.02 CHANGE PROPOSALS

A. Submit a Change Proposal (CP) to the Construction Manager for Contractor initiated changes in the Contract Documents or in response to a Request for Change Proposal. Submit the Change Proposal and attach the forms provided by the Construction Manager.

1. Use the Change Proposal form provided by the Construction Manager.

2. Include with the Change Proposal:

a. A complete description of the proposed Modification if Contractor initiated or proposed changes to the OPT's description of the proposed Modification.

b. The reason the Modification is requested, if not in response to a Request for a Change Proposal.

c. A detailed breakdown of the cost of the change if the Modification requires a change in Contract Price. The itemized breakdown is to include:

1) List of materials and equipment to be installed;

2) Man hours for labor by classification;

3) Equipment used in construction;

4) Consumable supplies, fuels, and materials;

5) Royalties and patent fees;

6) Bonds and insurance;

7) Overhead and profit;

8) Field office costs;

9) Home office cost; and

10) Other items of cost.

d. Provide the level of detail outlined in the paragraph above for each Subcontractor or Supplier actually performing the Work if Work is to be provided by a

Subcontractor or Supplier. Indicate appropriate Contractor mark ups for Work provided through Subcontractors and Suppliers. Provide the level of detail outlined in the paragraph above for self-performed Work.

e. Submit Change Proposals that comply with the General Conditions for Cost of Work.

f. Provide a revised schedule. Show the effect of the change on the Project Schedule and the Contract Times.

B. Submit a Change Proposal to the Construction Manager to request a Field Order.

C. A Change Proposal is required for all substitutions or deviations from the Contract Documents.

D. Request changes to products in accordance with Section 01 33 02 “Shop Drawings.”

1.03 CONSTRUCTION MANAGER WILL EVALUATE THE REQUEST FOR A MODIFICATION

A. Construction Manager will issue a Modification per the General Conditions if the Change Proposal is acceptable to the Owner. Construction Manager will issue a Change Order or Contract Amendment for any changes in Contract Price or Contract Times.

1. Change Orders and Contract Amendments will be sent to the Contractor for execution with a copy to the Owner recommending approval. A Work Change Directive may be issued if Work needs to progress before the Change Order or Contract Amendment can be authorized by the Owner.

2. Work Change Directives, Change Orders, and Contract Amendments can only be approved by the Owner.

a. Work performed on the Change Proposal prior to receiving a Work Change Directive or approval of the Change Order or Contract Amendment is performed at the Contractor’s risk.

b. No payment will be made for Work on Change Orders or Contract Amendments until approved by the Owner.

B. Contractor may be informed that the Change Proposal is not approved and construction is to proceed in accordance with the Contract Documents.

1.04 EQUAL NON-SPECIFIED PRODUCTS

A. The products of the listed manufacturers are to be furnished where the Specifications list several manufacturers and do not specifically list “or equal” or “or approved equal” products. Use of any products other than those specifically listed is a substitution. Follow the procedures in Paragraph 1.05 for a substitution.

B. Contractor may submit other manufacturers’ products that are in full compliance with the Specifications where Specifications list one or more manufacturers followed by the phase “or equal” or “or approved equal.”

1. Submit a Shop Drawing as required by Section 01 33 02 “Shop Drawings” to document that the proposed product is equal or superior to the specified product.

2. Prove that the product is equal. It is not the OPT's responsibility to prove the product is not equal.

    a. Indicate on a point-by-point basis for each specified feature that the product is equal to the Contract Document requirements.

    b. Make a direct comparison with the specified manufacturer's published data sheets and available information. Provide this printed material with the Shop Drawing.

    c. The decision of the Design Professional regarding the acceptability of the proposed product is final.

3. Provide a certification that, in furnishing the proposed product as an equal, the Contractor:

    a. Has thoroughly examined the proposed product and has determined that it is equal or superior in all respects to the product specified.

    b. Has determined that the product will perform in the same manner and result in the same process as the specified product.

    c. Will provide the same warranties and/or bonds as for the product specified.

    d. Will assume all responsibility to coordinate any modifications that may be necessary to incorporate the product into the construction and will waive all claims for additional Work which may be necessary to incorporate the product into the Project which may subsequently become apparent.

    e. Will maintain the same time schedule as for the specified product.

C. A Change Proposal is not required for any product that is in full compliance with the Contract Documents. If the product is not in full compliance, it may be offered as a Substitution.

1.05 SUBSTITUTIONS

A. Substitutions are defined as any product that the Contractor proposes to provide for the Project in lieu of the specified product. Submit a Change Proposal per Paragraph 1.02 along with documents required for a Shop Drawing as required by Section 01 33 02 "Shop Drawings" to request approval of a substitution.

B. Prove that the product is acceptable as a substitute. It is not the Design Professional's responsibility to prove the product is not acceptable as a substitute.

1. Indicate on a point-by-point basis for each specified feature that the product is acceptable to meet the intent of the Contract Documents requirements.

2. Make a direct comparison with the specified Suppliers published data sheets and available information. Provide this printed material with the Shop Drawing.

3. The decision of the Design Professional regarding the acceptability of the proposed substitute product is final.

C. Provide a certification that, in making the substitution request, the Contractor:

1. Has determined that the substituted product will perform in substantially the same manner and result in the same ability to meet the specified performance as the specified product;

2. Will provide the same warranties and/or bonds for the substituted product as specified or as would be provided by the manufacturer of the specified product;

3. Will assume all responsibility to coordinate any modifications that may be necessary to incorporate the substituted product into the Project and will waive all claims for additional Work which may be necessary to incorporate the substituted product into the Project which may subsequently become apparent; and

4. Will maintain the same time schedule as for the specified product.

D. Pay for review of substitutions in accordance with Section 01 33 02 “Shop Drawings.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 29 00 APPLICATION FOR PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Submit Applications for Payment for completed Work and for materials and equipment in accordance with the General Conditions, the Supplementary Conditions, the Agreement, and this Section. The Contract Price is to include costs for:

1. Providing the Work in accordance with the Contract Documents.
2. Installing Owner furnished equipment and materials, if any.
3. Providing Work for alternates and allowances, if any.
4. Providing Work for extra work Items, if any and if authorized.
5. Commissioning, startup, training, and initial maintenance and operation.
6. Acceptance testing at the manufacturer's facilities or at the Site.
7. All home office overhead costs and expenses, including profit made directly or indirectly from the Project.
8. Project management, contract administration, and field office and field operations staff including supervision, clerical support, and technology system support.
9. Professional services including design fees, legal fees, and other professional services.
10. Bonds and insurance.
11. Permits, licenses, patent fees, and royalties.
12. Taxes.
13. Providing all documentation and Samples required by the Contract Documents.
14. Facilities and equipment at the Site including:
    a. Field offices, office furnishings, and all related office supplies, software, and equipment,
    b. Storage facilities for Contractor's use and storage facilities for stored materials and equipment including spare parts storage,
    c. Shops, physical plant, construction equipment, small tools, vehicles, and technology and telecommunications equipment,
    d. Safety equipment and facilities to provide safe access and working conditions for workers and for others working at the Site,
    e. Temporary facilities for power and communications,
    f. Potable water and sanitation facilities, and
    g. Mobilization and demobilization for all these facilities and equipment.
15. Products, materials, and equipment stored at the Site or other suitable location in accordance with Section 01 31 00 "Project Management and Coordination".

16. Products, materials, and equipment permanently incorporated into the Project.
17. Temporary facilities for managing water including facilities for pumping, storage, and treatment as required for construction and protection of the environment.
18. Temporary facilities for managing environmental conditions and Constituents of Concern.
19. Temporary facilities such as sheeting, shoring, bracing, formwork, embankments, storage facilities, working areas, and other facilities required for construction of the Project.
20. Temporary and permanent facilities for protection of all overhead, surface, or underground structures or features.
21. Temporary and permanent facilities for removal, relocation, or replacement of any overhead, surface, or underground structures or features.
22. Products, materials, and equipment consumed during the construction of the Project.
23. Contractor labor and supervision to complete the Project including that provided through Subcontractors or Suppliers.
24. Correcting Defective Work during the Contract Times, during the Correction Period, or as required to meet any warranty provision of the Contract Documents.
25. Risk associated with weather and environmental conditions, startup, and initial operation of facilities including equipment, processes, and systems.
26. Contractor safety programs, including management, administration, and training.
27. Maintenance of facilities including equipment, processes, and systems until operation is transferred to Owner.
28. Warranties, extended or special warranties, or extended service agreements.
29. Cleanup and disposal of any and all surplus materials.
30. Demobilization of all physical, temporary facilities not incorporated into the Project.

B. Include the cost not specifically set forth as an individual payment item but required to provide a complete and functional system in the Contract Price.

C. Provide written approval of the surety company providing performance and payment bonds for the Schedule of Values, Application for Payment form, and method of payment prior to submitting the first Application for Payment. Submit approval using the Consent of Surety Company to Payment Procedures form provided by the Construction Manager. Payment will not be made without this approval.

D. Construction Manager may withhold processing the Applications for Payment if any of the following processes or documentation is not up to date:

1. Progress Schedule per Section 01 33 05 “Construction Progress Schedule.”
2. Project videos and photographs per Section 01 33 06 “Graphic Documentation.”
3. Record Documents per Section 01 31 13 “Project Coordination.”

4. Documentation required to comply with Section 00 73 39 “Minority/Women Business Enterprise Participation Program.”

1.02 SCHEDULE OF VALUES

A. Divide the Contract Price into an adequate number of line items to allow more accurate determination of the earned value for each line item when evaluating progress payments. Submit a detailed Schedule of Values for the Project at least 10 days prior to submitting the first Application for Payment using forms provided by the Construction Manager.

B. Do not apply for payment until the Schedule of Values has been approved by the Construction Manager.

C. Divide the cost associated with each line item in the Schedule of Values into installation and materials components.

1. Installation cost is to include all cost associated with the line item except materials cost.

2. Materials cost is the direct cost (as verified by invoice values) for products, materials, and equipment to be permanently incorporated into the Project associated with the line item.

3. Installation cost is to include all direct costs and a proportionate amount of the indirect costs for the Work associated with each line item. Include costs not specifically set forth as an individual payment item but required to provide a complete and functional system.

4. The sum of materials and installation costs for all line items must equal the Contract Price.

D. Use each unit price line item in the Agreement as a line item in the Schedule of Values. The sum of materials and installation costs for each line item for unit price contracts must equal the value of the line item in the Agreement. In addition to the installation cost described in Paragraph 1.02.C.3, installation costs for unit price items are to include costs for waste and overages.

1. Installation and materials cost may be left as a single installation component if:

a. Contractor does not intend to request payment for stored materials for that line item; or

b. Work in the line item will be completed within a single payment period.

2. Provide adequate detail to allow a more accurate determination of the earned value for installation costs, expressed as a decimal fraction of Work completed, for each line item.

3. Installation cost line items may not exceed $50,000.00. Items that are not subdivided into smaller units may only be included in the Application for Payment when Work on the entire unit is complete.

4. Lump sum items may be divided into an estimated number of units to estimate earned value. The estimated number of units times the cost per unit must equal the lump sum amount for that line item.

5. Include Contractor's overhead and profit in the installation costs each line item in proportion to the value of the line item to the Contract Price.

6. Include cost not specifically set forth as an individual payment item but required to provide a complete and functional system in the Contract Price for each item.

7. Line items may be used to establish the value of Work to be added or deleted from the Project.

E. Include a breakdown of both mobilization and demobilization costs in the Schedule of Values. The total cost for both mobilization and demobilization may not exceed 5% percent of the total Contract Price. Payment for mobilization and demobilization will be based on the earned value of Work completed. Payment for these costs will only be made for Work completed for the following:

1. Bonds and insurance;

2. Transportation and setup for equipment;

3. Transportation and/or erection of all field offices, sheds, and storage facilities;

4. Salaries for preparation of documents required before the first Application for Payment; and

5. Salaries for field personnel directly related to the mobilization of the Project.

1.03 SCHEDULE OF ANTICIPATED PAYMENTS

A. Submit a schedule of the anticipated Application for Payments showing the anticipated application numbers, submission dates, and the amount to be requested for each Application for Payment on the form provided by the Construction Manager.

B. Update the schedule of anticipated payments as necessary to provide a reasonably accurate indication of the funds required to make payments each month to the Contractor for Work performed.

1.04 ALTERNATES, ALLOWANCES, AND EXTRA WORK ITEMS

A. Include line items and amounts for specified alternate Work and allowances for Work in the Agreement, if any, and as described in Section 01 23 10 "Alternates and Allowances."

B. Include line items and amounts for Extra Work items in the Agreement, if any, and as described in Section 01 29 01 "Measurement and Basis for Payment."

1.05 RETAINAGE AND SET-OFFS

A. Retainage will be withheld from each Application for Payment per the Agreement.

B. Reduce payments for set-offs per the General Conditions as directed by the Construction Manager.

1.06 PROCEDURES FOR SUBMITTING AN APPLICATION FOR PAYMENT

A. Payment is based on the total earned value of Work completed in the previous month in accordance with the Schedule of Values established as provided in the General Conditions.

B. Submit a draft Application for Payment to the Construction Manager by the 10th day of each month. Do not submit Applications for Payment more often than monthly. Review the draft Application for Payment with the Construction Manager to determine concurrence with:

1. Values requested for materials and equipment, stored or incorporated into the Project as documented by invoices.
2. The earned value for installation costs for each line item in the Application for Payment form expressed as a percent complete for that line item.
3. The quantity of Work completed for each unit price item.
4. Amount of retainage to be held; and
5. Set-offs included in the Application for Payment.

C. Submit Applications for Payment to the Construction Manager after agreement has been reached on the draft Application for Payment with the Construction Manager.

D. Provide all information requested in the Application for Payment form. Do not leave any blanks incomplete. If information is not applicable, enter "N/A" in the space provided.

1. Number each application sequentially and include the dates for the application period.
2. Complete the Contract Time Summary on the Application for Payment form. If "Days Final Completion is (ahead/behind) Schedule" (line q) shows Project is more than 30 days behind schedule, revise the Schedule of Anticipated Payments to correspond to the updated schedule required per Section 01 33 05 "Construction Progress Schedule."
3. Complete the Summary of Earned Value and Set-offs on the Application for Payment form. Show the total amounts for earned value of original Contract performed, earned value for Work on approved Contract Amendments and Change Orders, retainage and set-offs.
4. Sign and date the Contractor's Certification on the Application for Payment form that all Work, including materials, covered by this Application for Payment have been completed or delivered and stored in accordance with the Contract Documents, that all amounts have been paid for Work, materials, and equipment for which previous Payment has been made by the Owner, and that the current payment amount shown in this Application for Payment is now due.
5. Include Attachment A - Tabulation of Earned Value of Original Contract Performed to show the value of materials stored and successfully incorporated into the Project and the earned value for installation of the Work for each line item in the Application for Payment for Work. Attachment A includes Work on the original Contract Price and on approved Contract Amendments and Change Orders.
6. Include Attachment B - Tabulation of Values for Materials and Equipment to track invoices used to support amounts requested as materials in Attachment A. Enter materials to show the amount of the invoice assigned to each item in Attachment A if an invoice includes materials used on several line items.
7. Include Attachment C - Summary of Set-offs to document set-offs made per the Contract Documents. Show each set-off as it is applied. Show a corresponding line

item to reduce the set-off amount if a payment held by a set-off is released for payment.

8. Include Attachment D - Retainage Calculation to show method for calculating retainage. The amount of retainage with respect to progress payments is stipulated in the Agreement. Any request for a reduction in retainage must be accompanied by a Consent of Surety to Reduction or Partial Release of Retainage.

9. Include Attachment E - EVA Calculation and the EVA Chart showing the anticipated and actual Total Earned Value of Fees, Work, and Materials. Create a graphic representation (curve) of the anticipated progress on the Project each month. Compare the anticipated cumulative Total Earned Value of Fees, Work, and Materials to the actual Total Earned Value of Fees, Work, and Materials to determine performance on budget and schedule. Adjust the table and curve to incorporate Modifications.

E. Submit attachments in Portable Document Format (PDF).

1. Generate attachments to the Application for Payment using the Excel spreadsheet provided by the Construction Manager.

2. Submit PDF documents with adequate resolution to allow documents to be printed in a format equivalent to the document original. Documents are to be scalable to allow printing on standard 8-1/2 x 11 or 11 x 17 paper.

1.07 ADJUSTMENTS TO THE SCHEDULE OF VALUES IN THE APPLICATION FOR PAYMENT

A. Submit a Change Proposal to request any changes to the Schedule of Values incorporated into the Application for Payment once approved. A Field Order will be issued by the Construction Manager to modify the Application for Payment form if approved.

B. Payment for materials and equipment shown in the Application for Payment will be made for the total of associated invoice amounts, up to the value shown for materials in the Application for Payment for that line item.

1. If the total amount for invoices for materials and equipment for a line item are less than the amount shown for the materials component of that line item in the Application for Payment, and it can be demonstrated that no additional materials or equipment are required to complete Work described in that item, the difference between the total invoice for materials and equipment and the materials component for that line item can be added to the installation component of that Work item.

2. Costs for material and equipment in excess of the value shown in the Schedule of Values may not be paid for under other line items.

1.08 CONSTRUCTION MANAGER'S RESPONSIBILITY

A. Construction Manager will review each draft Application for Payment with Contractor to reach an agreement on the amount to be recommended to Owner for payment. Contractor is to revise the Application for Payment to incorporate changes, if any, resulting from this review process.

B. Construction Manager will review the Application for Payment to determine that the Application for Payment has been properly submitted and is in accordance with the agreed to draft Application for Payment.

C. Construction Manager will either recommend payment of the Application for Payment to Owner or notify the Contractor of the reasons for not recommending payment. Contractor may make necessary corrections and resubmit the Application for Payment. Construction Manager will review resubmitted Application for Payment and reject or recommend payment of the Application for Payment to Owner as appropriate.

D. Construction Manager's recommendation of the Application for Payment constitutes a representation that based on its experience and the information available:

1. The Work has progressed to the point indicated.
2. The quality of the Work is generally in accordance with the Contract Documents.
3. Requirements prerequisite to payment have been met.

E. This representation is subject to:

1. Further evaluation of the Work as a functioning whole.
2. The results of subsequent tests called for in the Contract Documents.
3. Any other qualifications stated in the recommendation.

F. Construction Manager does not represent by recommending payment that:

1. Inspections made to check the quality or the quantity of the Work as it was performed were exhaustive or extended to every aspect of the Work in progress; or
2. Other matters or issues that might entitle Contractor to additional compensation or entitle Owner to withhold payment to Contractor exist.

G. Neither Construction Manager's review of Contractor's Work for the purposes of recommending payments nor Construction Manager's recommendation of payment imposes responsibility on the Construction Manager or Owner:

1. To supervise, direct, or control the Work;
2. For the means, methods, techniques, sequences, or procedures of construction, or safety precautions and programs;
3. For Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
4. To make examinations to ascertain how or for what purposes Contractor has used the monies paid on account of the Contract Price; or
5. To determine that title to the Work, materials, or equipment has passed to Owner free and clear of Liens.

1.09 FINAL APPLICATION FOR PAYMENT

A. Include adjustments to the Contract Price per Paragraph B in the final Application for Payment for:

1. Approved Change Orders and Contract Amendments.

2. Allowances not previously adjusted by Change Order.
3. Deductions for Defective Work that have been accepted by the Owner.
4. Penalties and bonuses.
5. Deduction for all final set-offs.
6. Other adjustments if needed.

B. Construction Manager will prepare a final Change Order reflecting the approved adjustments to the Contract Price which have not been covered by previously approved Change Orders and, if necessary, to reconcile estimated unit price quantities with actual quantities.

C. Submit the final Application for Payment per the General Conditions, including the final Change Order. Provide the following with the final Application for Payment:

1. Evidence of payment or release of Liens on the forms provided by the Construction Manager and as required by the General Conditions.
2. Consent from surety to final payment.

D. Final payment will also require additional procedures and documentation per Section 01 70 00 “Execution and Closeout Requirements.”

1.10 PAYMENT BY OWNER

A. Owner is to pay the amount recommended for monthly payments within 30 days after receipt of the Construction Manager’s recommended Application for Payment.

B. Final payment may take longer than 30 days to process a final application for payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 29 01 MEASUREMENT AND BASIS FOR PAYMENT

PART 1 - GENERAL

1.01 PAYMENT FOR MATERIALS AND EQUIPMENT

A. Payment will be made for materials and equipment materials properly stored and successfully incorporated into the Project less the specified retainage.

B. Payment will be made for material or equipment approved for off-site storage only under the following conditions:

1. Payment will be made for 100 percent of the invoice amount for the material or equipment less the specified retainage.

2. Invoices for the material or equipment must be provided as for other stored materials.

3. Provisions must be made to allow material or equipment to be inventoried by the Construction Manager each month material or equipment is added to or removed from inventory.

4. Contractor will pay time and expenses for:

a. Inspections of manufacturing facilities not located in the local area; and

b. Inspections of the site for the purpose of taking inventory of the material or equipment.

5. Title will transfer ownership of the material or equipment to the Owner per Paragraph 1.01.E.

6. Contractor provides a letter from the surety company agreeing to the payment for the material or equipment under these conditions.

7. Contractor, at its expense, must provide insurance applicable to the storage of the material or equipment while in the Supplier's or Contractor's care, custody, and control. Provide evidence of insurance verifying the coverage during all periods of storage.

C. Provide a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of Liens. Provide documentation of payment for materials and equipment with the next Application for Payment. Remove items from the tabulation of materials and equipment if this documentation is not provided with the next Application for Payment.

D. Provide evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest.

E. The Work covered by progress payments becomes the property of the Owner at the time of payment. The Contractor's obligations with regard to proper care and maintenance, insurance, and other requirements are not changed by this transfer of ownership until final acceptance in accordance with the General Conditions.

F. Payment for materials and equipment does not constitute acceptance of the product.

1.02 MEASUREMENT AND BASIS FOR PAYMENTS ON LUMP SUM ITEMS

A. Measurement for progress payments is the invoice value for stored materials and the earned value for all other cost for constructing each item. Earned value is expressed as the value of the Work completed divided by the total value of installation cost. The total amount paid will be equal to the total lump sum amount for that item.

1.03 MEASUREMENT AND BASIS FOR PAYMENTS ON UNIT PRICE ITEMS

A. Measure the Work using the unit of measure indicated in this Section for each unit price line item. Payment will be made only for the actual measured unit and/or computed length, area, solid contents, number, and weight unless other provisions are made in the Contract Documents. Payment on a unit price basis will not be made for Work outside dimensions shown in the Contract Documents.

B. Payment will be made for the actual quantity of Work completed and for materials and equipment stored during the payment period. Payment amount is the Work quantity measured per Paragraph A above multiplied by the unit price for that line item in the Agreement.

1.04 MEASUREMENT AND BASIS FOR PAYMENT FOR BASE ITEMS

A. Item A-01 – West High Service Pump Station Pump 4 & 5 Additions

1. Measuring for payment is on a lump sum basis. Payment will be based on the earned value of Work completed.

1.05 MEASUREMENT AND BASIS FOR PAYMENT FOR ALLOWANCES

A. Item D-01 - Owner’s Contingency Allowance:

1. Contract Price includes this Owner’s Contingency. Payment will be made from this contingency only for approved Change Orders.

2. Payment will be made based on Change Order cost calculated in accordance with the General Conditions and Section 01 26 00 “Change Management.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 31 00 PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish resources required to complete the Project in accordance with the Contract Documents and within the Contract Times.

B. Construct Project in accordance with current safety practices.

C. Manage Site to allow access to Site and control construction operations. Coordinate site access with the Owners.

D. Construct temporary facilities to provide and maintain control over environmental conditions at the Site. Remove temporary facilities when no longer needed.

E. Provide temporary controls for pollution, management of water, and management of excess earth as required in Section 01 57 00 “Temporary Controls.”

1.02 STANDARDS

A. Perform Work to comply with:

1. Requirements of the Contract Documents;

2. Laws and Regulations; and

3. Specified industry standards.

1.03 DOCUMENTATION

A. Provide documents in accordance with Section 01 33 00 “Document Management.”

B. Provide copies of Supplier’s printed storage instructions prior to furnishing materials or products and installation instructions prior to beginning the installation.

C. Incorporate field notes, sketches, recordings, and computations made by the Contractor in Record Drawings per Section 01 31 13 “Project Coordination.”

1.04 PERMITS

A. Obtain building permits for the Project from the local authorities having jurisdiction. Building permit fees will be paid by the Owner.

B. Obtain environmental permits required for construction at the Site.

C. Provide required permits for transporting heavy or oversized loads.

D. Provide other permits required to conduct any part of the Work.

E. Arrange for inspections and certification by agencies having jurisdiction over the Work and include the cost for these inspections and certifications in the Contract Price.

F. Make arrangements with private utility companies and pay fees associated with obtaining services or inspections.

G. Retain copies of permits and licenses at the Site and comply with all regulations and conditions of the permit or license.

1.05 SAFETY REQUIREMENTS

A. Manage safety to protect the safety and welfare of persons at the Site.

B. Provide safe access to move through the Site. Provide protective devices to warn and protect from hazards at the Site.

C. Provide safe access for those performing tests and inspections.

D. Maintain a supply of personal protective equipment for visitors to the Site.

E. Comply with latest provisions of the Occupational Health and Safety Administration (OSHA) and other Laws and Regulations.

F. Cooperate with accident investigations. Provide two copies of all reports, including insurance company reports, prepared concerning accidents, injuries, or deaths related to the Project to the Construction Manager as Record Data per Section 01 31 13 “Project Coordination.”

1.06 ACCESS TO THE SITE

A. Maintain access to the facilities at all times. Do not obstruct roads, pedestrian walks, or access to the various buildings, structures, stairways, or entrances. Provide safe access for normal operations during construction.

B. Provide adequate and safe access for inspections. Leave ladders, bridges, scaffolding, and protective equipment in place until inspections have been completed. Construct additional safe access if required for inspections.

C. Use roadways for construction traffic only with written approval of the appropriate representatives of each entity. Roadways may not be approved for construction traffic. Obtain written approval to use roads to deliver heavy or oversized loads to the Site. Furnish copies of the written approvals to the Construction Manager as Record Data per Section 01 31 13 “Project Coordination.”

1.07 CONTRACTOR’S USE OF THE SITE

A. Limit the use of Site for Work and storage to those areas designated on the Drawings or approved by the Construction Manager. Coordinate the use of the Site with the Construction Manager.

B. Provide security at the Site as necessary to protect against vandalism and loss by theft per Section 01 15 00 “Construction Site Security Procedures”.

C. Park construction equipment in designated areas only and provide spill control measures as discussed in Section 01 57 00 “Temporary Controls.”

D. Park employees’ vehicles in designated areas only.

E. Obtain written permission of the property owner before entering privately-owned land outside of the Owner’s property, rights-of-way, or easements.

F. Cooperate with public and private agencies with facilities operating within the limits of the Project. Provide 48 hours' notice to any applicable agency when Work is anticipated to proceed in the vicinity of any facility by using the City of Arlington Line Locate Process online for Arlington Water Utility lines and Texas one-call system at 811 or 1-800-344-8377 or 1-888-313-4747.

G. Conduct of Contractor's or Subcontractor's Employees:

1. Do not permit alcoholic beverages or illegal substances on the Site. Do not allow persons under the influence of alcoholic beverages or illegal substances to enter or remain on the Site at any time. Persons on Site under the influence of alcoholic beverages or illegal substances will be permanently prohibited from returning to the Site. Criminal or civil penalties may also apply.

2. Do not allow the use of offensive language or sexual harassment in any form. These actions will cause immediate and permanent removal of the offender from the premises. Criminal or civil penalties may apply.

3. Require workers to wear clothing that is inoffensive and meets safety requirements. Do not allow sleeveless shirts, shorts, or any exceedingly torn, ripped, or soiled clothing to be worn on the Site.

4. Do not allow the use, possession, concealment, transportation, promotion, or sale of the following prohibited items anywhere on the Site:

   a. Firearms (including air rifles and pistols and BB or pellet guns) and ammunition;

   b. Bows, crossbows, arrows, bolts, or any other projectile weapons;

   c. Explosives of any kind, including fireworks;

   d. Illegal knives;

   e. Other weapons prohibited by state Laws and Regulations; and

   f. Any other item that has been designed or intended to be used as a weapon.

   No exceptions will be made for the possession of a firearm by a person that has a valid state-issued license to carry a firearm. Remove any of the prohibited items listed above from the Site immediately and permanently. Any person found to be in possession of any prohibited item must also be removed from the Site and may be reported to local law enforcement.

1.08 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. Examine the Site and review the available information concerning the Site. Locate utilities, underground facilities, and existing structures. Verify the elevations of the structures adjacent to excavations. Report any discrepancies from information in the Contract Documents to the Construction Manager before beginning construction.

B. Determine if existing structures, poles, piping, or other utilities at excavations will require relocation or replacement. Prepare a Plan of Action per Section 01 31 13 "Project Coordination." Coordinate Work with local utility company and others for the relocation or replacement.

C. Protect utilities, underground facilities and existing structures unless they are shown to be replaced or relocated on the Drawings. Restore damaged items to the satisfaction of the Owner and utility or property owner.

D. Carefully support and protect all structures and/or utilities so that there will be no failure or settlement where excavation or demolition endangers adjacent structures and utilities. Do not take existing utilities out of service unless required by the Contract Documents or approved by the Construction Manager. Notify and cooperate with the utility owner if it is necessary to move services, poles, guy wires, pipelines, or other obstructions.

E. Protect existing trees and landscaping at the Site. Mark trees that may be removed during construction and review with the Construction Manager for approval before removing. Protect trees to remain from damage limiting activity, including stockpiling of materials within the drip line of the tree.

F. Protect buildings from damage when handling material or equipment. Protect finished surfaces, including floors, doors, and jambs. Remove doors and install temporary wood protective coverings over jambs, if needed.

1.09 DISRUPTION TO SERVICES/CONTINUED OPERATIONS

A. Owner's facilities are to continue in service as usual during the construction unless noted otherwise. Owner or utilities must be able to operate and maintain the facilities. Keep disruptions to existing utilities, piping, process piping, or electrical services to a minimum.

1. Do not restrict access to critical valves, operators, or electrical panels.

2. Do not store material or products inside structures unless authorized by the Construction Manager.

3. Limit operations to the minimum amount of space needed to complete the specified Work.

4. Maintain storm sewers and sanitary sewers in service at all times. Provide temporary service around the construction or otherwise construct the Work in a manner that flow is not restricted.

B. Provide a Plan of Action in accordance with Section 01 35 00 "Special Procedures" if facilities must be taken out of operation.

1.10 FIELD VERIFICATION

A. Perform complete field measurements prior to purchasing products or beginning construction for products required to fit existing conditions.

B. Verify property lines, control lines, grades, and levels indicated on the Drawings.

C. Verify pipe class, equipment capacities, existing electrical systems, and power sources for existing conditions.

D. Check Shop Drawings and indicate the actual dimensions available where products are to be installed.

E. Include field measurements in Record Documents as required in Section 01 31 13 "Project Coordination."

1.11 REFERENCE DATA AND CONTROL POINTS

A. Construction Manager will provide the following control points:

1. Base line or grid reference points for horizontal control.

2. Benchmarks for vertical control.

B. Locate and protect control points prior to starting the Work and preserve permanent reference points during construction. Designated control points may be on an existing structure or monument. Do not change or relocate points without prior approval of the Construction Manager. Notify Construction Manager when a reference point is lost, destroyed, or requires relocation. Replace Project control points on the basis of the original survey. Control points or benchmarks damaged, disturbed or destroyed as a result of the Contractor's negligence will be restored by the Construction Manager. Owner will impose a set-off as compensation for the effort required.

C. Provide complete engineering layout of the Work needed for construction.

1. Provide competent personnel. Provide equipment including accurate surveying instruments, stakes, platforms, tools, and materials.

2. Provide surveying with accuracy meeting the requirements as established in the Manual of Practice for Land Surveying in the State of Texas published by the Texas Society of Professional Surveyors, latest revision.

3. Provide Record Data per Section 01 31 13 "Project Coordination" and measurements per standards.

1.12 DELIVERY AND STORAGE

A. Deliver products and materials to the Site in time to prevent delays in construction.

B. Deliver packaged products to Site in original undamaged containers with identifying labels attached. Open cartons as necessary to check for damage and to verify invoices. Reseal cartons and store properly until used. Leave products in original packages or other containers until installed. If original packages or containers are damaged, repackage in containers and include packing slips, labels and other information from the original packaging.

C. Deliver products that are too large to fit through openings to the Site in advance of the time enclosing walls and roofs are erected. Set in place, raised above floor on cribs or pallets.

D. Assume full responsibility for the protection and safekeeping of products stored at the Site.

E. Store products at locations acceptable to the Construction Manager and to allow Owner access to maintain and operate existing facilities.

F. Store products in accordance with the Supplier's storage instructions immediately upon delivery. Leave seals and labels intact. Arrange storage to allow access for maintenance of stored items and for inspection. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.

G. Provide additional storage areas as needed for construction. Store products subject to damage by elements in substantial weather-tight enclosures or storage sheds. Provide and

maintain storage sheds as required for the protection of products. Provide temperature, humidity control, and ventilation within the ranges stated in the Supplier's instructions. Remove storage facilities at the completion of the Project.

H. Protect the pipe interior. Keep all foreign materials such as dirt, debris, animals, or other objects out of the pipe during the Work.

I. Provide adequate exterior storage for products that may be stored out-of-doors.

1. Provide substantial platforms, blocking, or skids to support materials and products above ground which has been sloped to provide drainage. Protect products from soiling or staining.

2. Cover products subject to discoloration or deterioration from exposure to the elements, with impervious sheet materials. Provide ventilation to prevent condensation below covering.

3. Store loose, granular materials on clean, solid surfaces, or on rigid sheet materials, to prevent mixing with foreign matter.

4. Provide surface drainage to prevent erosion and ponding of water.

5. Prevent mixing of refuse or chemically injurious materials or liquids with stored materials.

6. Pipes and conduits stored outdoors are to have open ends sealed to prevent the entrance of dirt, moisture, and other injurious materials. Protect PVC pipe from ultraviolet light exposure.

7. Store products to prevent wind damage.

J. Protect and maintain mechanical and electrical equipment in storage.

1. Provide Supplier's service instructions on the exterior of the package.

2. Service equipment on a regular basis as recommended by the Supplier. Maintain a log of maintenance services. Submit the log as Record Data per Section 01 31 13 "Project Coordination" when Owner assumes responsibility for maintenance and operation.

3. Provide power to and energize space heaters for all equipment for which these devices are provided.

4. Provide temporary enclosures for all electrical equipment, including electrical systems on mechanical devices. Provide and maintain heat in the enclosures until equipment is energized.

K. Maintain storage facilities. Inspect stored products on a weekly basis and after periods of severe weather to verify that:

1. Storage facilities continue to meet specified requirements;

2. Supplier's required environmental conditions are continually maintained; and

3. Products that can be damaged by exposure to the elements are not adversely affected.

L. Replace any stored item damaged by inadequate protection or environmental controls.

M. Payment may be withheld for any products not properly stored.

1.13 CLEANING DURING CONSTRUCTION

A. Provide positive methods to minimize raising dust from construction operations and provide positive means to prevent air-borne dust from disbursing into the atmosphere. Control dust and dirt from demolition, cutting, and patching operations.

B. Clean the Site as Work progresses and dispose of waste materials, keeping the Site free from accumulations of waste or rubbish. Provide containers at the Site for waste collection. Do not allow waste materials or debris to blow around or off of the Site. Control dust from waste materials. Transport waste materials with as few handlings as possible.

C. Comply with Laws and Regulations. Do not burn or bury waste materials. Remove waste materials, rubbish, and debris from the Site and legally dispose of these at public or private disposal facilities.

1.14 MAINTENANCE OF ROADS, DRIVEWAYS, AND ACCESS

A. Maintain roads and streets in a manner that is suitable for safe operations of public vehicle during all phases of construction unless the Owner approves a street closing. Do not close public roads overnight. Coordinate and arrange for emergency vehicle access when streets are to be closed.

B. Submit a Notification by Contractor for Owner's approval of a street closing. The request must state:

1. The reason for closing the street.

2. How long the street will remain closed.

3. Procedures to be taken to maintain the flow of traffic.

C. Obtain permits and permissions of the entity that owns the road prior to any Work and provide a copy of the permit or permission Record Data per Section 01 31 13 "Project Coordination."

D. Construct temporary detours, including by-pass roads around construction, with adequately clear width to maintain the free flow of traffic at all times. Maintain barricades, signs, and safety features around the detour and excavations. Maintain barricades, signs, and safety features around the Work in accordance with all provisions of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).

E. Assume responsibility for any damage resulting from construction along roads or drives.

1.15 BLASTING

A. Blasting is not allowed for any purpose.

1.16 ARCHAEOLOGICAL REQUIREMENTS

A. Cease operations immediately and contact the Owner for instructions if historical or archaeological artifacts are found during construction.

B. Conduct all construction activities to avoid adverse impact of the sites where significant historical or archaeological artifacts are found or identified as an area where other artifacts could be found.

1. Obtain details for working in these areas from regulatory agencies.
2. Maintain confidentiality regarding the site(s) of artifacts.
3. Adhere to the requirements of applicable local, state, and federal Laws and Regulations.
4. Notify the Construction Manager and any local, state, or federal agency as required by applicable Laws and Regulations.

C. Do not disturb archaeological sites.

1. Obtain the services of a qualified archaeological specialist to instruct construction personnel on how to identify and protect archaeological finds on an emergency basis.
2. Coordinate activities to permit archaeological work to take place within the area.
    a. Attempt to archaeologically clear areas needed for construction as soon as possible.
    b. Provide a determination of priority for such areas.

D. Assume responsibility for any unauthorized destruction that might result to such sites by construction personnel, and pay all penalties assessed by state or federal agencies for non-compliance with these requirements.

E. Contract Times will be modified to compensate for delays caused by such archaeological finds. No additional compensation will be paid for delays.

1.17 ENDANGERED SPECIES RESOURCES

A. Do not perform any activity that is likely to destroy or adversely modify the habitat or jeopardize the continued existence of a threatened or endangered species as listed or proposed for listing under the Federal Endangered Species Act (ESA) or applicable state Laws and Regulations.

B. Cease Work immediately in the area of the encounter and notify the Construction Manager if a threatened or endangered species is encountered during construction. Construction Manager will implement actions in accordance with the ESA and applicable state statutes. Resume construction in the area of the encounter when authorized to do so by the Construction Manager.

1.18 PRELIMINARY OCCUPANCY

A. Owner may deliver, install, and connect equipment, furnishings, or other apparatus in buildings or other structures. These actions do not indicate acceptance of any part of the building or structure and does not affect the start of warranties or correction periods.

B. Protect the Owner’s property after installation is complete.

C. Owner may use any product for testing or to determine that the product meets the requirements of the Contract Documents. This use does not constitute acceptance by OPT. These actions do not indicate acceptance of any part of the product and does not affect the start of warranties or correction periods.

1.19 OCCUPANCY

A. Owner has the right to occupy or operate any portion of the Project that is ready for use after notifying the Contractor of its intent to do so.

B. Testing of equipment and appurtenances including specified test periods, training, and startup does not constitute acceptance for operation.

C. Owner may accept the facility for continued use after startup and testing at the option of the Owner. If acceptance is delayed at the option of the Owner, shut down facilities per approved operation and maintenance procedures.

D. The execution of bonds is understood to indicate the consent of the surety to these provisions for occupancy of the structures and use of equipment.

E. Provide an endorsement from the insurance carrier permitting occupancy of the structures and use of equipment during the remaining period of construction.

F. Conduct operations to ensure the least inconvenience to the Owner and general public.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 31 13 PROJECT COORDINATION

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Administer contract requirements to construct the Project. Provide documentation per the requirements of this Section. Provide information as requested by the OPT.

1.02 DOCUMENTATION

A. Provide documents in accordance with Section 01 33 00 “Document Management.”

1.03 COMMUNICATION DURING THE PROJECT

A. Construction Manager is to be the first point of contact for all parties on matters concerning this Project.

B. Construction Manager will coordinate correspondence concerning:

1. Contract administration;
2. Clarification and interpretation of the Contract Documents;
3. Contract modifications;
4. Observation of Work and testing; and
5. Claims.

C. Construction Manager will normally communicate only with the Contractor. Any required communication with Subcontractors or Suppliers will only be with the direct involvement of the Contractor.

D. Direct written communications to the Construction Manager at the address indicated at the pre-construction conference. Include the following with communications as a minimum:

1. Name of the Owner;
2. Project name;
3. Contract title;
4. Project number;
5. Date; and
6. A reference statement.

E. Submit communications on the forms referenced in this Section or in Section 01 33 00 “Document Management.”

1.04 PROJECT MEETINGS

A. Pre-Construction Conference:

1. Attend a pre-construction conference;
2. The location of the conference will be determined by the Construction Manager.

3. The time of the conference will be determined by the Construction Manager, but will be after the Notice of Award is issued and not later than 15 days after the Notice to Proceed is issued;
4. The OPT, Contractor's project manager and superintendent, representatives of utility companies, and representatives from major Subcontractors and Suppliers may attend the conference; and
5. Provide and be prepared to discuss:
    a. Preliminary construction schedule per Section 01 33 05 "Construction Progress Schedule";
    b. Preliminary Schedule of Documents per Section 01 33 00 "Document Management";
    c. Schedule of Values and anticipated schedule of payments per Section 01 29 00 "Application for Payment Procedures";
    d. List of Subcontractors and Suppliers;
    e. Contractor's organizational chart as it relates to this Project; and
    f. Letter indicating the agents of authority for the Contractor and the limit of that authority with respect to the execution of legal documents, contract modifications, and payment requests.

B. Progress Meetings:
1. Attend meetings with the Construction Manager, Design Professional, and Owner.
    a. Meet monthly or as requested by the Construction Manager to discuss the Project.
    b. Meet at the Site or other location as designated by the Construction Manager.
    c. Contractor's superintendent and other key personnel are to attend the meeting. Other individuals may be requested to attend to discuss specific matters.
    d. Notify the Construction Manager of any specific items to be discussed a minimum of 1 week prior to the meeting.
2. Provide information as requested by the Construction Manager, Design Professional or Owner concerning this Project. Prepare to discuss:
    a. Status of overall project schedule;
    b. Contractor's detailed schedule for the next month;
    c. Anticipated delivery dates for equipment;
    d. Coordination with the Owner;
    e. Status of documents;
    f. Information or clarification of the Contract Documents;
    g. Claims and proposed modifications to the Contract;
    h. Field observations, problems, or conflicts; and

i. Maintenance of quality standards.

3. Construction Manager will prepare a record of meeting proceedings. Review the record of the meeting and notify the Construction Manager of any discrepancies within 10 days of the date the record of the meeting is provided. The record will not be corrected after the 10 days have expired. Corrections will be reflected in the record of the following meeting.

C. Pre-Documentation and Pre-Installation Meetings:

1. Conduct pre documentation and pre installation meetings as required in the individual technical Specifications or as determined necessary by the Construction Manager (for example, instrumentation, roofing, concrete mix design, etc.).

2. Set the time and location of the meetings when ready to proceed with the associated Work. Submit a Notification by Contractor in accordance with Paragraph 1.07 for the meeting 2 weeks before the meeting. OPT must approve of the proposed time and location.

3. Attend the meeting and require the participation of appropriate Subcontractors and Suppliers in the meeting.

4. Construction Manager will prepare a record of meeting proceedings. Review the record of the meeting and notify the Construction Manager of any discrepancies within 10 days of the date the record of the meeting is provided. The record will not be corrected after the 10 days have expired. Corrections will be reflected in the record of the following meeting.

D. Weekly Coordination Meetings: Meet on a weekly basis with the Construction Manager or designated on-site representative of the OPT to discuss Work planned for the following week, review coordination issues, testing required, or other issues. Records of these meetings are not required.

1.05 REQUESTS FOR INFORMATION

A. Submit a Request for Information to the Construction Manager to obtain additional information or clarification of the Contract Documents.

1. Submit a separate Request for Information for each item on the form provided by the Construction Manager.

2. Attach adequate information to permit a response without further clarification. Construction Manager will return requests that do not have adequate information to the Contractor for additional information. Contractor is responsible for all delays resulting from multiple reviews due to inadequate information.

3. A response will be made when adequate information is provided. The response will be made on the Request for Information form provided by the Construction Manager.

B. Response to a Request for Information is given to provide additional information, interpretation, or clarification of the requirements of the Contract Documents, and does not modify the Contract Documents.

1. Submit a Change Proposal per Section 01 26 00 “Change Management” if a contract modification is suggested or required.

C. Use the Decision Register to document decisions made at meetings and actions to be taken in accordance with Paragraph 1.06.

D. Use the Action Item Register to document assignments for actions to be taken in accordance with Paragraph 1.06.

1.06 DECISION AND ACTION ITEM REGISTER

A. Construction Manager will maintain a Decision Register to document key decisions made during meetings, telephone conversations, or visits to the Site using the format provided by the Construction Manager:

1. Review the Decision Register prior to each regular meeting.

2. Report any discrepancies to the Construction Manager for correction or discussion at the next monthly meeting.

B. Construction Manager will maintain an Action Item Register in conjunction with the Decision Register to track assignments made during meetings, telephone conversations or visits to the Site using the format provided by the Construction Manager:

1. Review the Action Item Register prior to each regular meeting.

2. Report actions taken after the previous progress meeting on items in the register assigned to the Contractor or through the Contractor to a Subcontractor or Supplier to the Construction Manager. Report on status of progress 1 week prior to each progress meeting established in Paragraph 1.04 to allow Construction Manager to update the register prior to the Progress Meetings.

3. Be prepared to discuss the status at each meeting.

C. Decisions or action items in the register that require a change in the Contract Documents will have the preparation of a Modification as an action items if appropriate. The Contract Documents can only be changed by a Modification.

1.07 NOTIFICATION BY CONTRACTOR

A. Notify the Construction Manager of:

1. Need for testing;

2. Intent to work outside regular working hours;

3. Request to shut down facilities or utilities;

4. Proposed utility connections;

5. Required observation by Construction Manager, Engineer, or inspection agencies prior to covering Work; and

6. Training.

B. Provide notification a minimum of 2 weeks in advance in order to allow OPT time to respond appropriately to the notification.

C. Use the Notification by Contractor form provided by the Construction Manager.

1.08 REQUESTS FOR MODIFICATIONS

A. Submit requests for Modifications per Section 01 26 00 “Change Management.”

1.09 PLAN OF ACTION

A. Submit a written Plan of Action for approval for shutting down essential services. These include:
   1. Electrical power;
   2. Control power;
   3. Process piping;
   4. Process equipment;
   5. Communications equipment; and
   6. Other designated functions.

B. Describe the following in the Plan of Action:
   1. Scheduled dates for construction;
   2. Work to be performed;
   3. Utilities, piping, or services affected;
   4. Length of time the service or utility will be disturbed;
   5. Procedures to be used to carry out the Work;
   6. Plan of Action to handle emergencies;
   7. List of manpower, equipment, and ancillary supplies;
   8. Backups for key pieces of equipment and key personnel;
   9. Contingency plan that will be used if the original schedule cannot be met; and

C. Submit plan 1 month prior to beginning the Work.

1.10 RECORD DATA

A. Submit information required by the Contract Documents that is not related to a product as Record Data using the form provided by the Construction Manager.

1.11 RECORD DOCUMENTS

A. Maintain one complete set of printed Record Documents at the Site including:
   1. Drawings;
   2. Specifications;
   3. Addenda;
   4. Modifications;
   5. Product Data and approved Shop Drawings;

6. Construction photographs;
7. Test Reports;
8. Clarifications and other information provided in Request for Information responses; and
9. Reference standards.

B. Store printed Record Documents and Samples in the Contractor's field office.
1. Record Documents are to remain separate from documents used for construction.
2. Provide files and racks for the storage of Record Documents.
3. Provide a secure storage space for the storage of Samples.
4. Maintain Record Documents in clean, dry, legible conditions, and in good order.
5. Make Record Documents and Samples available at all times for inspection by the OPT.

C. Maintain an electronic record of Specifications and Addenda to identify products provided in PDF format.
1. Reference the Product Data number, Shop Drawing number, and O&M manual number for each product and item of equipment furnished or installed.
2. Reference Modifications by type and number for all changes.

D. Maintain an electronic record of Drawings in PDF format.
1. Reference the Product Data number, Shop Drawing number, and O&M manual number for each product and item of equipment furnished or installed.
2. Reference Modifications by type and number for all changes.
3. Record information as construction is being performed. Do not conceal any Work until the required information is recorded.
4. Mark drawings to record actual construction.
    a. Depths of various elements of the foundation in relation to finished first floor datum or the top of walls.
    b. Horizontal and vertical locations of underground utilities and appurtenances constructed, and existing utilities encountered during construction.
    c. Location of utilities and appurtenances concealed in the Work. Refer measurements to permanent structures on the surface. Include the following equipment:
        1) Piping;
        2) Ductwork;
        3) Equipment and control devices requiring periodic maintenance or repair;
        4) Valves, unions, traps, and tanks;
        5) Services entrance;
        6) Feeders; and

7) Outlets.

d. Changes of dimension and detail.

e. Changes by Modifications.

f. Information in Requests for Information or included in the Decision Register.

g. Details not on the original Drawings. Include field verified dimensions and clarifications, interpretations, and additional information issued in response to Requests for Information.

5. Mark Drawings with the following colors:

a. Highlight references to other documents, including Modifications in blue.

b. Highlight mark ups for new or revised Work (lines added) in yellow.

c. Highlight items deleted or not installed (lines to be removed) in red.

d. Highlight items constructed per the Contract Documents in green.

6. Submit Record Documents to Construction Manager for review and acceptance 30 days prior to Final Completion of the Project.

E. Applications for Payment will not be recommended for payment if Record Documents are found to be incomplete or not in order. Final payment will not be recommended without complete Record Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 00 DOCUMENT MANAGEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Submit documentation as required by the Contract Documents and as requested by the Construction Manager.

B. Use the e-Builder Project Management Information System (PMIS) provided by the City of Arlington. Software has the following system requirements:

1. Operating Systems: Windows 7 or later and OS X v10.8 or later.

2. Supported Internet Browsers: Internet Explorer 11.0 or later, Google Chrome 70.0 or later, Firefox 63.0 or later, Safari 11.0 or later, and Microsoft Edge 17.0 or later.

3. Screen Resolution: The recommended screen resolution is 1280 x 1024 or higher. The minimum screen resolution required to support all features is 1024 x 768.

C. Contractor will be provided access to e-Builder for up to 3 persons. Additional seats may be available at an additional cost which will be applied to the contract as a set off.

1.02 QUALITY ASSURANCE

A. Submit legible, accurate, complete documents presented in a clear, easily understood manner. Documents not meeting these criteria will be returned without review as “Not Approved.”

1.03 CONTRACTOR’S RESPONSIBILITIES

A. Review documents prior to submission. Make certifications as required by the Contract Documents and as indicated on Construction Manager provided forms.

B. Provide a Schedule of Documents to list the documents that are to be submitted, the dates on which documents are to be sent to the Construction Manager for review. Use the form provided by the Construction Manager for this list.

C. Incorporate the dates for processing documents into the Progress Schedule required by Section 01 33 05 “Construction Progress Schedule.”

1. Provide documents in accordance with the schedule so construction of the Project is not delayed.

2. Allow a reasonable time for the review of documents when preparing the Progress Schedule. Assume a 14-day review cycle for each document unless a longer period of time is indicated in the Contract Documents or agreed to by Construction Manager and Contractor.

3. Schedule delivery of review documents to provide all information for interrelated Work at one time.

4. Allow adequate time for processing documents so construction of the Project is not delayed.

1.04 FORMS AND WORKFLOWS

A. Use the forms or workflow process provided by the Construction Manager for project documentation.

1.05 DOCUMENT PREPARATION AND DELIVERY PROCEDURES

A. Deliver documents in electronic format as directed by the Construction Manager.

1. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.

2. Deliver all documents in Portable Document Format (PDF).

a. Create PDF document using Bluebeam Revu software.

b. Create PDF documents from native format files unless files are only available from scanned documents.

c. Rotate pages so that the top of each document appears at the top of the monitor screen when opened in PDF viewing software.

d. Provide PDF document with adequate resolution to allow documents to be printed in a format equivalent to the document original. Documents are to be scalable to allow printing on standard 8-1/2 x 11 or 11 x 17 paper.

e. Submit color PDF documents where color is required to interpret the document.

f. Create or convert documents to allow text to be selected for comments or searched using text search features. Run scanned documents through Optical Character Recognition (OCR) software if necessary.

g. Flatten markups in documents to prevent markups made by Contractor from being moved or deleted. Flatten documents to allow markup recovery.

h. Use Bluebeam Revu software to reduce file size using default settings except the option for “Drop Metadata”. Uncheck the “Drop Metadata” box when reducing file size.

i. Add footers to each document with the name of the Project.

B. Software Requirements:

1. OPT and Contractor will each acquire the software and software licenses necessary to create and transmit Electronic Documents and to read and to use any Electronic Documents received from the other party (and if relevant from third parties), using the following software formats:

Document	Document Format
Email	.htm, .rtf, or .txt without formatting that impairs legibility of content on screen or in printed copies
Submittals	Bluebeam PDF
Applications for Payment	Bluebeam PDF and Microsoft® Excel
Progress Schedules	PDF and Schedule in Native Format

Document	Document Format
Layouts and drawings to be submitted to Owner for future use and modification.	Autodesk® AutoCAD .dwg format
Document submitted to OPT for future word processing use and modification.	Microsoft® Word
Spreadsheets and data submitted to OPT for future data processing use and modification.	Microsoft® Excel

2. Software will be the version currently published at the time Contract is signed, unless a specific software version in listed in the Supplementary Conditions. Prior to using any updated version of the software required in this Section for sending Electronic Documents to the other party, the originating party will first notify and receive concurrence from the other party for use of the updated version or convert to comply with this Paragraph.

1.06 DOCUMENTATION

A. Furnish documents as indicated in the individual Specification Sections. Submit documents per the procedures described in the Contract Documents.

B. Submit documents per the Specification Sections shown in the following table:

Document Type	Specification Section
Application for Payment	01 29 00
Certified Test Report	01 33 02 for approval of product
Change Management	01 26 00
Equipment Installation Report	01 75 00
Graphic Documentation	01 33 06
Notification by Contractor	01 31 13
Operation & Maintenance Manuals	01 33 04
Product Data	01 33 03
Progress Schedules	01 33 05
Record Data	01 31 13
Request for Information	01 31 13
Schedule of Values	01 29 00
Shop Drawing	01 33 02
Substitutions	01 26 00
Suppliers and Subcontractors	01 31 13 01 33 03

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 02 SHOP DRAWINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Shop Drawings are required for those products that cannot adequately be described in the Contract Documents to allow fabrication, erection, or installation of the product without additional detailed information from the Supplier.

B. Submit Shop Drawings as required by the Contract Documents and as reasonably requested by the Construction Manager to:

1. Record the products incorporated into the Project;

2. Provide detailed information for the products proposed for the Project regarding their fabrication, installation, commissioning, and testing; and

3. Allow the Design Professional to advise the Owner if products proposed for the Project by the Contractor conform, in general, to the design concepts of the Contract Documents.

C. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the review of Shop Drawings, Samples, or mockups.

D. Submit a Change Proposal per Section 01 26 00 "Change Management" to request modifications to the Contract Documents, including those for approval of "or equal" products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures. Deviations from the Contract Documents can only be approved Change Order or Field Order.

1.02 QUALITY ASSURANCE

A. Submit legible, accurate, and complete documents presented in a clear, easily understood manner. Shop Drawings not meeting these criteria will not be approved.

B. Demonstrate that the proposed products are in full compliance with the design criteria and requirements of the Contract Documents or will be if deviations requested per Paragraph 1.11 are approved.

C. Furnish and install products that fully comply with the information included in the Shop Drawings.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Furnish Shop Drawings for products as indicated in the individual Specification Sections.

B. Include Shop Drawings as indicated in the individual Specification Sections to indicate the Shop Drawings to be submitted, the dates on which Shop Drawings are to be sent to the Construction Manager for review, and proposed dates that the product will be incorporated into the Project.

C. Incorporate the dates for processing Shop Drawings into the Progress Schedule required by Section 01 33 05 "Construction Progress Schedule."

1. Submit Shop Drawings in accordance with the schedule so construction of the Project is not delayed.
2. Submit Shop Drawings for interrelated Work at one time.
3. Allow adequate time for ordering, fabricating, delivering, and installing products so construction of the Project is not delayed.

D. Complete the following before submitting a Shop Drawing or Sample:

1. Prepare and review the Shop Drawing or Sample. Coordinate the Shop Drawing or Sample with other Shop Drawings and Samples, with the requirements of the Work, and the Contract Documents;
2. Determine and verify specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to Shop Drawings and Samples;
3. Determine and verify the suitability of materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
4. Determine and verify information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

E. Determine and verify:

1. Field measurements, quantities, and dimensions are shown on the Shop Drawing and are accurate;
2. Location of existing structures, utilities, and equipment related to the Shop Drawing have been shown and conflicts between the products, existing structures, utilities, and equipment have been identified;
3. Conflicts that impact the installation of the products have been brought to the attention of the Construction Manager;
4. Shop Drawing is complete for its intended purpose; and
5. Conflicts between the Shop Drawing related to the various Subcontractors and Suppliers have been resolved.

F. Review Shop Drawings prior to submitting to the Construction Manager. Certify that all Shop Drawings have been reviewed by the Contractor and are in strict conformance with the Contract Documents as modified by Addenda, Change Order, Field Order, or Contract Amendment when submitting Shop Drawings except for deviations specifically brought to the Construction Manager's attention on an attached Shop Drawing Deviation Request form in accordance with Paragraph 1.11.

G. Fabrication or installation of any products prior to the approval of Shop Drawings is done at the Contractor's risk. Defective products may be rejected at the Owner's option.

H. Payment will not be made for products for which Shop Drawings or Samples are required until these are approved by the Construction Manager and Design Professional.

1.04 DOCUMENTATION

A. Provide adequate information in Shop Drawings and with Samples so the Design Professional can:

1. Assist the Owner in selecting colors, textures, or other aesthetic features.

2. Compare the proposed features of the product with the specified features and advise Owner that the product does, in general, conform to the Contract Documents.

3. Compare the performance features of the proposed product with those specified and advise the Owner that the product does, in general, conform to the performance criteria specified in the Contract Documents.

4. Review required certifications, guarantees, warranties, and service agreements for compliance with the Contract Documents.

B. Include a complete description of the material or equipment to be furnished, including:

1. Type, dimensions, size, arrangement, model number, and operational parameters of the components;

2. Weights, gauges, materials of construction, external connections, anchors, and supports required;

3. Performance characteristics, capacities, engineering data, motor curves, and other information necessary to allow a complete evaluation of mechanical components;

4. All applicable standards;

5. Fabrication and installation drawings, setting diagrams, manufacturing instructions, templates, patterns, and coordination drawings;

6. Wiring and piping diagrams and related controls;

7. Mix designs for concrete, asphalt, or other materials proportioned for the Project; and

8. Complete and accurate field measurements for products which must fit existing conditions. Indicate on the document that the measurements represent actual dimensions obtained at the Site.

C. Submit Shop Drawings that require coordination with other Shop Drawings for fabrication at the same time. Shop Drawings requiring coordination with other Shop Drawings will not be approved until a complete package is submitted, unless approved by the Construction Manager.

D. Submit information for all of the components and related equipment required for a complete and operational system in one Submittal.

1. Include electrical, mechanical, and other information required to indicate how the various components of the system function together as a system.

2. Provide certifications, warranties, and written guarantees and service contracts with the document package for review when these are required.

1.05 SPECIAL CERTIFICATIONS AND REPORTS

A. Provide all required special certifications, reports, and other documentation with the Shop Drawings as specified in the individual Specification Sections which may include:

1. Certified Test Reports (CTR): A report prepared by an approved testing agency giving results of tests performed on products to indicate their compliance with the Specifications. This report is to demonstrate that the product, when installed, will meet the requirements of the Contract Documents and is part of the Shop Drawing. Field tests may be performed by the Owner to determine that in place materials or products meet the same quality as indicated in the CTR submitted as part of the Shop Drawing.

2. Certification of Local Field Service (CLS): A certified letter stating that field service is available from a factory or supplier approved service organization located within a 300-mile radius of the Site. Include the names, addresses, and telephone numbers of approved service organizations with the certificate.

3. Certification of Adequacy of Design (CAD): A certified letter from the manufacturer of the equipment stating that the equipment has been designed to be structurally stable and to withstand all imposed loads without deformation, failure, or adverse effects to the performance and operational requirements of the unit. The letter must state that mechanical and electrical components have been adequately sized to be fully operational for the conditions specified or normally encountered by the product's intended use.

4. Certification of Applicator/Subcontractor (CSQ): A certified letter stating that the applicator or subcontractor proposed to perform a specified function is duly designated as factory authorized and trained for the application of the specified product.

1.06 WARRANTIES AND SERVICE AGREEMENTS

A. Provide warranties and service agreements per Section 01 78 36 "Warranties and Service Agreements."

1.07 SHOP DRAWING SUBMITTAL PROCEDURES

A. Submit Shop Drawings to the Construction Manager. Send all documents in digital format for processing.

1. Provide all information requested. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.

2. Submit all documents in Portable Document Format (PDF) as required by Section 01 33 00 "Document Management." Provide color PDF documents where color is required to interpret the Shop Drawing. Provide Samples and color charts per Paragraph 1.10.

3. Submit each specific product, class of material, or equipment system separately so these can be tracked and processed independently. Do not submit Shop Drawings for more than one independent system in the same Submittal.

4. Submit items specified in different Specification Sections separately unless they are part of an integrated system.
5. Define abbreviations and symbols used in Shop Drawings.
    a. Use terms and symbols in Shop Drawings consistent with the Contract Drawings.
    b. Provide a list of abbreviations and their meaning as used in the Shop Drawings.
    c. Provide a legend for symbols used on Shop Drawings.
6. Mark Shop Drawings to reference:
    a. Related Specification Sections;
    b. Drawing number and detail designation;
    c. Equipment designation or name;
    d. Schedule references;
    e. System into which the product is incorporated; and
    f. Location where the product is incorporated into the Project.

B. Use the following conventions to markup Shop Drawings for review:
1. Make comments and corrections in the color blue. Add explanatory comments to the markup.
2. Highlight items in black (redact) that are not being furnished when the Supplier's standard drawings or information sheets are provided so that only the products to be provided are in their original color.
3. Make comments in yellow where selections or decisions by the Design Professional are required, but such selections do not constitute a deviation from the Contract Documents. Add explanatory comments to the markup to indicate the action requested of the Design Professional.
4. Make comments in orange that are deviation requests. Include the deviation request number on the Shop Drawing that corresponds to the deviation request on the Shop Drawing Deviation Request form. Include explanatory comments in the Shop Drawing Deviation Request form.
5. Mark dimensions with the prefix "FD" to indicate field verified dimensions on the Shop Drawings.

C. Designate a document as requiring priority treatment to place the review of the Shop Drawing ahead of other Shop Drawings previously delivered. Shop Drawings are typically reviewed in the order received, unless Contractor requests that a different priority be assigned. Priority Shop Drawings will be reviewed before other Shop Drawings already received but not yet reviewed. Use of this priority designation for Shop Drawings may delay the review of Shop Drawings previously submitted. Contractor is responsible for delays resulting from the use of the priority designation status on Shop Drawings.

D. Complete the certification required by Paragraph 1.03.G.

1.08 SAMPLE AND MOCKUP SUBMITTAL PROCEDURES

A. Submit color charts and Samples for every product requiring color, texture, or finish selection.

1. Submit color charts and Samples only after Shop Drawings for the products have been approved.

2. Deliver all color charts and Samples at one time.

3. Provide Samples of adequate size to clearly illustrate the functional characteristics of the product, with integrally related parts and attachment devices.

4. Indicate the full range of color, texture, and patterns.

5. Deliver color charts and Samples to the field office and store for the duration of the Project.

6. Notify the Construction Manager that color charts and Samples have been delivered for approval using the Notification by Contractor form.

7. Submit color charts and Samples not less than 30 days prior to when these products are to be ordered or released for fabrication to comply with the Project schedule.

8. Remove Samples that have not been approved. Submit new Samples following the same process as for the initial Sample until Samples are approved.

9. Dispose of Samples when related Work has been completed and approved and disposal is approved by the Construction Manager. At Owner's option, Samples will become the property of the Owner.

B. Construct mockups for comparison with the Work being performed.

1. Construct mockups from the actual products to be used in construction per the detailed specifications.

2. Construct mockups of the size and in the area indicated in the Contract Documents.

3. Construct mockups complete with texture and finish to represent the finished product.

4. Notify the Construction Manager that mockups have been constructed and are ready for approval using the Notification by Contractor form. Allow 2 weeks for Construction Manager to approve of the mockup before beginning the Work represented by the mockup.

5. Remove mockups that have not been approved. Construct new mockups following the same process as for the initial mockup until mockup is approved.

6. Protect mockups until Work has been completed and accepted by the Construction Manager.

7. Dispose of mockups when related Work has been completed and disposal is approved by the Construction Manager.

1.09 REQUESTS FOR DEVIATION

A. Submit a Change Proposal per Section 01 26 00 "Change Management" to request modifications to the Contract Documents, including those for approval of "or equal"

products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures.

B. Provide a Shop Drawing with the Change Proposal that clearly identifies deviations for any product or component of the product that does not fully comply with the Contract Documents using the Shop Drawing Deviation Request form provided by the Construction Manager. Mark deviations on the Shop Drawing per Paragraph 1.09.B

C. Include a description of why the deviation is required and the impact on Contract Price or Contract Times. Include the amount of any cost savings to the Owner for deviations that result in a reduction in cost.

D. Identify each deviation request as a separate item. Include all requested deviations that must be approved as a group together and identify them as a single item.

E. Construction Manager will issue a Field Order or Change Order to approve acceptable deviations. Approval of a requested Shop Drawing deviation by the Design Professional on the Shop Drawings Deviation Request form indicates approval of the requested deviation only on its technical merits as generally conforming to the Contract Documents. Deviations from the Contract Documents can only be approved by a Modification issued by the Construction Manager.

1.10 CONSTRUCTION MANAGER AND DESIGN PROFESSIONAL RESPONSIBILITIES

A. Shop Drawings will be received by the Construction Manager. Construction Manager will log the documents and forward to the Design Professional for review per this Section for general conformance with the Contract Documents.

1. Design Professional's review and approval will be only to determine if the products described in the Shop Drawing or Sample 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. Design Professional's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.

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

B. Comments will be made on items called to the attention of the Design Professional for review and comment. Any marks made by the Design Professional do not constitute a blanket review of the document or relieve the Contractor from responsibility for errors or deviations from the Contract requirements.

1. Design Professional will respond to Contractor's markups by either making markups directly in the Shop Drawing file using the color red or by attaching a Document Review Comments form with review comments keyed to the Drawings or Shop Drawing Deviation Request.

2. Shop Drawings that are reviewed will be returned with one or more of the following status designations:

    a. Approved: Shop Drawing is found to be acceptable as submitted.

    b. Approved as Noted: Shop Drawing is approved so long as corrections or notations made by Design Professional are incorporated into the Shop Drawing.

    c. Not Approved: Shop Drawing or products described are not acceptable.

    d. Cancelled: This action indicates that for some reason, the Shop Drawing is to be removed from consideration and all efforts regarding the processing of that document are to cease.

3. Shop Drawings will also be designated for one of the following actions:

    a. Documents Filed: Shop Drawing is acceptable without further action and has been filed as a record document.

    b. Shop Drawing Not Required: A Shop Drawing was not required by the Contract Documents. Resubmit the document per Section 01 33 03 “Product Data.”

    c. Cancelled: This action indicates that for some reason, the Shop Drawing is to be removed from consideration and all efforts regarding the processing of that document are to cease.

    d. Revise and Resubmit: Shop Drawing has deviations from the Contract Documents, significant errors, or is inadequate and must be revised and resubmitted for subsequent review.

    Actions “a” through “c” will close out the Shop Drawing review process and no further action is required as a Shop Drawing. Action “d” requires follow up action to close out the review process.

4. Drawings with a significant or substantial number of markings by the Contractor may be marked “Approved as Noted.” These drawings are to be revised to provide a clean record of the document. Proceed with ordering products as the documents are revised.

5. Dimensions or other data that do not appear to conform to the Contract Documents will be marked as “At Variance With” (AVW) the Contract Documents or other information provided. The Contractor is to make revisions as appropriate to comply with the Contract Documents.

C. Bring deviations to the Shop Drawings to the attention of the Design Professional for approval by using the Shop Drawing Deviation Request form. Use a single line for each requested deviation so the Status and Action for each deviation can be determined for that requested deviation. If approval or rejection of a requested deviation will impact other requested deviation, then all related deviations should be included in that requested deviation line so the status and action can be determined on the requested deviation as a whole.

D. Requested deviations will be reviewed as a possible Modification to the Contract Documents.

1. A requested deviation will be marked as “Not Approved” if the requested deviation is unacceptable. Contractor is to revise and resubmit the Shop Drawing with corrections for approval.

2. A Field Order will be issued by the Construction Manager for deviations approved by the Design Professional if the requested deviation is acceptable and if the requested deviation will not result in a change in Contract Price or Contract Times. Requested deviations from the Contract Documents may only be approved by Field Order.

3. A requested deviation will not be approved if the requested deviation is acceptable but the requested deviation will or should result in a change in Contract Price or Contract Times. Submit any requested deviation that requires a change in Contract Price or Contract Times as a Change Proposal for approval prior to resubmitting the Shop Drawing.

E. Contractor is to resubmit a complete Shop Drawing incorporating revisions until it is acceptable and marked “Approved” or “Approved as Noted” and is assigned an action per Paragraph 1.12.B.3 that indicates that the Shop Drawing process is closed.

F. Information that is submitted as a Shop Drawing that should be submitted as Product Data or other type of document, or is not required may be returned without review, or may be deleted. No further action is required and the Shop Drawing process for this document will be closed.

1.11 RESUBMISSION REQUIREMENTS

A. Make all corrections or changes required by the Design Professional in the document and resubmit to the Construction Manager until approved.

B. Resubmit a complete Shop Drawing for each resubmittal. The last approved Shop Drawing must not rely on previous submissions. The final Shop Drawing is to provide a complete record for the Owner’s records.

C. Revise initial drawings or data and resubmit as specified for the reviewed document.

1. Highlight or cloud in green those revisions which have been made in response to the previous reviews by the Design Professional. This will include changes previously highlighted or clouded in yellow to direct attention to Design Professional to items requiring selections, decisions by the Design Professional or highlighted or clouded in orange for a requested deviation from the Contract Documents, or comments in red made by the Construction Manager.

2. Highlight and cloud new items in yellow where selections or decisions by the Design Professional are required, but such selections do not constitute a deviation from the Contract Documents. Add explanatory comments to the markup to indicate the action to be taken by the Design Professional.

3. Highlight and cloud new items in orange that are deviation requests. Include the deviation request number on the Shop Drawing that corresponds to the deviation request on the Shop Drawing Deviation Request form. Numbering for these new items is to start with the next number following the last Shop Drawing deviation requested. Include explanatory comments in the Shop Drawing Deviation Request form.

D. Pay for excessive review of Shop Drawings.

1. Excessive review of Shop Drawings is defined as any review required after the original review has been made and the first resubmittal has been checked to see that corrections have been made.
2. Review of Shop Drawings or Samples will be an additional service requiring payment by the Contractor if the Contractor submits a substitution for a product for which a Shop Drawing or Sample has previously been approved, unless the need for such change is beyond the control of Contractor.
3. Cost for additional review time will be billed to the Owner by the Design Professional for the actual hours required for the review of Shop Drawings by Design Professional and in accordance with the rates listed in Section 00 73 00 “Supplementary Conditions.”
4. A set-off will be included in each Application for Payment to pay the cost for the additional review. The set-off will be based on invoices submitted to the Owner for these services.
5. Need for more than one resubmission or any other delay in obtaining Design Professional’s approval of Shop Drawings will not entitle the Contractor to an adjustment in Contract Price or an extension of Contract Times.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 03 PRODUCT DATA

PART 1 - GENERAL

1.01 SUMMARY

A. Submit Product Data as required by the Contract Documents and as reasonably requested by the Construction Manager. Provide Product Data for all products unless a Shop Drawing is required for the same item.

B. Submit Product Data to provide documents that allow the Owner to:

1. Record the products incorporated into the Project;

2. Record detailed information about products regarding their fabrication, installation, commissioning, and testing; and

3. Provide replacement or repair of products at some future date.

C. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the receipt or cursory review of Product Data.

D. Submit a Change Proposal per Section 01 26 00 "Change Management" to request modifications to the Contract Documents, including those for approval of "or equal" products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures. Deviations from the Contract Documents can only be made by an approved Change Order or Field Order.

1.02 QUALITY ASSURANCE

A. Submit legible, accurate, and complete documents presented in a clear, easily understood manner. Product Data not meeting these criteria will not be accepted and must be resubmitted.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Furnish Product Data for products as indicated in the individual Specification Sections.

B. Include Product Data in the Document Register required by the individual Specification Sections to indicate the Product Data to be submitted, the dates on which documents are to be sent to the Construction Manager for review, and proposed dates that the product will be incorporated into the Project.

C. Complete the following before submitting Product Data:

1. Prepare Product Data and coordinate with Shop Drawings, Samples, Product Data for related products, and with the requirements of the Contract Documents;

2. Determine and verify specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information;

3. Determine and verify the suitability of materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. Determine and verify information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

D. Determine and verify:

1. Field measurements, quantities, and dimensions are shown on the Product Data and are accurate;

2. Location of existing structures, utilities, and equipment related to the Product Data have been shown and conflicts between the products, existing structures, utilities, and equipment have been brought to the attention of the Construction Manager;

3. Conflicts that impact the installation of the products have been brought to the attention of the Construction Manager;

4. Product Data is complete for its intended purpose; and

5. Conflicts between the Product Data related to the various Subcontractors and Suppliers have been resolved.

E. Review Product Data prior to submitting to the Construction Manager. Certify that all Product Data has been reviewed by the Contractor and is in strict conformance with the Contract Documents as modified by Addenda, Change Order, Field Order, or Contract Amendment when submitting Product Data.

1.04 DOCUMENTATION

A. Include a complete description of the material or equipment to be furnished, including:

1. Type, dimensions, size, arrangement, model number, and operational parameters of the components;

2. Weights, gauges, materials of construction, external connections, anchors, and supports required;

3. Performance characteristics, capacities, engineering data, motor curves, and other information necessary to allow a complete evaluation of mechanical components;

4. All applicable standards;

5. Fabrication and installation drawings, setting diagrams, manufacturing instructions, templates, patterns, and coordination drawings;

6. Wiring and piping diagrams and related controls;

7. Mix designs for concrete, asphalt, or other materials proportioned for the Project; and

8. Complete and accurate field measurements for products which must fit existing conditions. Indicate on the document that the measurements represent actual dimensions obtained at the Site.

B. Submit information for all components and related equipment required for a complete and operational system in one submittal.

1. Include electrical, mechanical, and other information required to indicate how the various components of the system function together as a system.

2. Provide certifications, warranties, and written guarantees and service contracts with the document package for review when these are required.

1.05 SPECIAL CERTIFICATIONS AND REPORTS

A. Provide all required certifications with the Product Data as specified in the individual Specification Sections:

1. Certified Test Reports (CTR): A report prepared by an approved testing agency giving results of tests performed on products to indicate their compliance with the Specifications. This report is to demonstrate that the product when installed will meet the requirements of the Contract Documents and is part of the Product Data. Field tests may be performed by the Owner to determine that in place materials or products meet the same quality as indicated in the CTR submitted as part of the Product Data.

2. Certification of Local Field Service (CLS): A certified letter stating that field service is available from a factory or supplier approved service organization located within a 300-mile radius of the Site. Include the names, addresses, and telephone numbers of approved service organizations with the certificate.

3. Certification of Adequacy of Design (CAD): A certified letter from the manufacturer of the equipment stating that the equipment has been designed to be structurally stable and to withstand all imposed loads without deformation, failure, or adverse effects to the performance and operational requirements of the unit. The letter must state that mechanical and electrical components have been adequately sized to be fully operational for the conditions specified or normally encountered by the product's intended use.

4. Certification of Applicator/Subcontractor (CSQ): A certified letter stating that the applicator or subcontractor proposed to perform a specified function is duly designated as factory authorized and trained for the application of the specified product.

1.06 WARRANTIES AND SERVICE AGREEMENTS

A. Provide warranties and service agreements per Section 01 78 36 "Warranties and Service Agreements."

1.07 PRODUCT DATA SUBMITTAL PROCEDURES

A. Submit Product Data to the Construction Manager. Send all documents in digital format for processing.

1. Provide all information requested. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.

2. Submit all documents in Portable Document Format (PDF) as required by Section 01 33 00 "Document Management." Provide color PDF documents where color is required to interpret the Product Data.

3. Submit each specific product, class of material, or equipment system separately so these can be tracked and processed independently. Do not submit Product Data for more than one system in the same Submittal.

4. Submit items specified in different Specification Sections separately unless they are part of an integrated system.
5. Define abbreviations and symbols used in Product Data.
    a. Use terms and symbols in Product Data consistent with the Contract Drawings.
    b. Provide a list of abbreviations and their meaning as used in the Product Data.
    c. Provide a legend for symbols used on Product Data.
6. Mark Product Data to reference:
    a. Related Specification Sections;
    b. Drawing number and detail designation;
    c. Equipment designation or name;
    d. Schedule references;
    e. System into which the product is incorporated; and
    f. Location where the product is incorporated into the Project.

B. Complete the certification required by Paragraph 1.03.F.

1.08 CONSTRUCTION MANAGER AND DESIGN PROFESSIONAL RESPONSIBILITIES

A. Product Data will be received by the Construction Manager, logged, and provided to Owner as the Project record.
1. Product Data may be reviewed to see that the information provided is adequate for the purpose intended. Product Data not meeting the requirements of Paragraph 1.02 may not be approved.
2. Product Data is not reviewed for compliance with the Contract Documents. Comments may be returned if deviations from the Contract Documents are noted during the cursory review performed to see that the information is adequate.
3. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the review of Product Data. Contract modifications can only be approved by a Change Order or Field Order.

B. Construction Manager may take the following action in processing Product Data:
1. File Product Data as received if the cursory review indicates that the document meets the requirements of Paragraph 1.02. Document will be marked "Filed as Received" and "Documents Filed." No further action is required on that Product Data.
2. Not approve the Product Data for one of the following reasons:
    a. The documentation requirements of the Contract Documents indicate that the document submitted as Product Data should have been submitted as a Shop Drawing. The Product Data will be marked "Not Approved" and "Submit as Shop Drawing". No further action is required on this document as Product Data and the Product Data process will be closed. Resubmit the document as a Shop Drawing per Section 01 33 02 "Shop Drawings."

b. The cursory review indicates that the document does not meet the requirements of Paragraph 1.02. The Product Data will be marked “Not Approved” and “Revise and Resubmit”. Contractor is to resubmit the Product Data until it is acceptable and marked “Filed as Received”. When Product Data is filed, no further action is required, and the Product Data process will be closed.

c. The Product Data is not required by the Contract Documents nor is applicable to the Project. The Product Data will be marked “Not Approved” and “Cancelled.” No further action is required, and the Product Data process will be closed.

C. Contractor is to resubmit the Product Data until it is acceptable and marked “Filed as Received”.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 04 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

A. Prepare a complete and detailed operation and maintenance manual (manual) for each type and model of equipment or product furnished and installed under this Contract.

B. Prepare manuals in the form of an instruction manual for the Owner. The manuals are to be suitable for use in providing the operation and maintenance instructions required by Section 01 79 00 “Training of Operation and Maintenance Personnel.”

C. Provide complete and detailed information specifically for the products or systems provided for this Project. Include the information required to operate and maintain the product or system.

D. Manuals are to be provided in addition to any information packed with or attached to the product when delivered. Remove information packed with or attached to the product and include this information as an attachment to the manual.

E. Include cost for manuals provided by Suppliers and Subcontractors as described in this Section in the Cost of Work for that equipment item.

1.02 DOCUMENTATION

A. Submit manuals in accordance with Section 01 33 00 “Document Management.” Attach a copy of the Operation and Maintenance Manual Review Report form provided by the Construction Manager to each manual with pertinent information completed.

B. Provide one preliminary electronic copy of the manual to the Construction Manager for review within 15 days after review of any equipment submittal by the OPT.

C. Provide one electronic copy and three printed copies of the final manual after:

1. Preliminary manuals have been approved;

2. Field test records have been incorporated into the manual; and

3. Record Documents per Section 01 31 13 “Project Coordination” have been approved and have been incorporated in the final manual.

D. Provide copies of the manufacturer’s warranties, guarantees, or service agreements in accordance with Section 01 70 00 “Execution and Closeout Requirements.”

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide electronic files for each manual as specified in Paragraph 2.02.

1. Use filenames that correspond to the equipment designation shown in the Contract Documents or other equipment designations provided by the OPT.

2. Submit a preliminary version of the electronic manual for review. Provide a final version of the manual incorporating OPT’s comments.

B. Provide 3 printed copies of each manual as specified in Paragraph 2.03.

2.02 ELECTRONIC MANUAL FORMAT

A. Manual contents are to be submitted in electronic format to the Construction Manager.

B. Provide individual electronic files for each manual.

1. Maximum file size is 75 MB. If manual is greater than maximum allowable file size, provide individual files for each major section of manual.

2. Acceptable file types for written documents are Portable Document File (PDF) or provide manual text in Microsoft Word. Provide drawings in native format and PDF format. All files must be compatible with the latest software version available.

3. Filename must identify the equipment location, equipment manufacturer, and date equipment placed in service, e.g. Pump Room-Manufacturer-200503.pdf.

4. Each electronic file must contain a table of contents at the beginning of the file which includes hypertext links or bookmarks to navigate the file contents per section/chapter.

5. Scanned images of written documents are not acceptable. Document must allow character selection. Text within a file must be transferable to other documents.

6. Drawing files must have the ability to turn on/off drawing layers within the file.

2.03 PRINTED MANUAL FORMAT

A. Printed copies of each manual are to be submitted as follows:

1. Print manuals on heavy, first quality 8-1/2 x 11 paper.

a. Reduce drawings and diagrams to 8-1/2 x 11 paper size.

b. When reduction is not practical, fold drawings and place each separately in a clear, super heavy weight, top loading polypropylene sheet protector designed for three-ring binder use. Provide a typed identification label on each sheet protector.

c. Punch paper for standard three-ring binders.

2. Place manuals in heavy duty presentation, d-ring binders with clear front, back, and spine covers.

3. Identify each manual by placing a printed cover sheet in the front cover of the binder and as the first page in the manual. The first page is to be placed in a clear polypropylene sheet protector. The information on first page and the cover page are to include:

a. Name of Owner;

b. Project name;

c. Volume number; and

d. Table of contents.

4. Insert the name of the Project and volume number into the spine covers.

5. Sheet lifters are to be provided.
6. Minimum size is 2-inch capacity. Maximum size is 3-inch capacity. Fill binders to only three-fourths of its indicated capacity to allow for addition of materials to each binder by the Owner.
7. Provide index tabs for each section of the manual. Indexes are to be constructed of heavy-duty paper with a reinforced binding edge. The designation on each index tab is to correspond to the number and letter assigned in the Table of Contents.
8. Manuals for several products or systems may be provided in the same binder. Correlate the data into related groups when multiple products or systems are included in the same binder.
    a. Sections for each product or system must be included in the same binder.
    b. Sections must be in numerical order from volume to volume.

PART 3 - EXECUTION

3.01 MANUAL ORGANIZATION AND CONTENTS

A. Provide a table of contents listing each section of the manual for each product or system.
    1. Assign a number and letter to each section in the manual.
        a. The number is to correspond to the Owner's equipment numbering system or other system designated in the Contract Documents.
        b. The letter assigned will represent the part of the manual, consistent with the manual contents as required by this Section.
    2. Identify each product or system using the nomenclature shown in the Contract Documents. Provide a cross reference to the Owner's numbering system and designations for equipment indicated in the Contract Documents if these are different.
B. Include only the information that pertains to the product described. Annotate each sheet to:
    1. Clearly identify the specific product or component installed;
    2. Clearly identify the data applicable to the installation; and
    3. Delete or strike through references to inapplicable information.
C. Supplement manual information with drawings as necessary to clearly illustrate relations of component parts of equipment and systems, and control and flow diagrams.
D. Manuals for several products or systems may be provided in the same binder.
E. Fill binders to only three-fourths of its indicated capacity to allow for addition of information by the Owner.

3.02 EQUIPMENT AND SYSTEMS MANUAL CONTENT

A. Provide the following information in the first tabbed section of each manual:
    1. A description of the unit and component parts and how it functions.

2. Operating instructions for pre-startup, startup, normal operations, regulation, control, shutdown, emergency conditions, and limiting operating conditions.

3. The sequence of operation by the controls manufacturer. Provide control diagrams by the manufacturer, modified to reflect the as-built, as-installed condition.

4. Include general assembly contract drawings, sections, and photographic views as necessary to completely depict and properly identify the equipment. Indicate the dimensions, weight, capacity, and design conditions for the equipment.

B. Include detailed information to allow for the proper installation, calibration, testing, preventative, and corrective maintenance procedures in the second section of the manual or of each section of the manual information if the manual covers a multi-component equipment system. This information should include the following:

1. Maintenance instructions including assembly, installation, alignment, clearances, tolerances, and interfacing equipment requirements, adjustment, and checking instructions. Include any special rigging required to place the equipment into place, and any special test equipment required to place the equipment in service.

2. A safety subsection which addresses all safety and tag-out procedures necessary to safely operate and maintain the equipment.

3. Lubrication schedule and lubrication procedures. Include a cross reference for recommended lubrication products.

4. Troubleshooting guide.

5. A table showing the schedule of routine maintenance requirements and seasonal work which is not performed at a set frequency. Preventative maintenance tasking must address:

   a. Daily/weekly inspections performed by operations personnel;

   b. Routine preventative maintenance scheduled weekly, monthly, quarterly, semi-annually, or annually through major overhauls by maintenance personnel; and

   c. Predictive maintenance work such as alignment, analysis of the equipment, vibration, flow, oil sampling, etc.

6. Description of sequence of operation by the control manufacturer.

7. Warnings for detrimental maintenance practices.

8. Detailed corrective maintenance procedures including:

   a. Detail equipment for complete disassembly and assembly;

   b. Cross-sectional drawings or exploded views with all parts numbered to correspond with the numbers in the parts list to permit identification of the various parts;

   c. A table of normal clearances, diameters, thickness of new parts, and limits permissible for wearing parts; and

   d. List torque settings for nuts, bolts, and fasteners when critical to the equipment's performance.

C. Include all necessary diagrammatic piping and wiring diagrams and miscellaneous contract drawings and equipment in the third section of the manual or of each section of the manual if the manual covers a multi-component equipment system.

D. Provide spare parts information in the fourth section of the manual including:

1. Part numbers for ordering new parts;
2. Assembly illustrations showing an exploded view of the complex parts of the product;
3. Predicted life of parts subject to wear;
4. List of the manufacturer's recommended spare parts, current prices with effective date, and number of parts recommended for storage;
5. Directory of a local source of supply for parts with company name, address, and telephone number;
6. Complete nomenclature and list of commercial replacement parts; and
7. Complete list of spare parts, spare equipment, tools, and materials that are turned over to the Owner.

E. Provide statistical information from the original equipment manufacturer as to performance such as pump curves, flow charts insulation resistance, calibration, or test data sheets in the fifth section of the manual, including all field-testing records used to verify actual performance.

F. Provide equipment name plate data installed on equipment and valves and equipment data sheets as required and furnished by the Owner in the sixth section of the manual.

G. Provide a copy of warranties and the date the warranty expires for equipment in the seventh section of the manual.

3.03 ELECTRICAL AND ELECTRONICS SYSTEMS MANUAL

A. Provide all the information listed in Paragraph 3.02 as appropriate and include the following information:

1. Control schematics and point to point wiring diagrams prepared for field installation;
2. Circuit directories of panel boards and terminal strips and as installed color-coded wiring diagrams; and
3. Other information as may be required by the individual Specification Sections.

3.04 ARCHITECTURAL PRODUCTS MANUAL

A. Provide the following information:

1. Information required for ordering replacement products;
2. Instructions for care and maintenance;
3. List of the manufacturer's recommended lubricants;
4. The manufacturer's recommendations for types of cleaning agents and methods;

5. Cautions against cleaning agents and methods that are detrimental to the product; and

6. Recommended maintenance and cleaning schedule.

B. Final balancing reports for mechanical systems.

C. Other information as may be required by the individual Specification Sections.

3.05 LIST OF SERVICE ORGANIZATIONS

A. Provide a directory of authorized service organizations with company name, address, telephone number, email address, and the contact person for warranty repair.

END OF SECTION

01 33 05 CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.01 SUMMARY

A. Prepare and submit a Progress Schedule for the Work and update the schedule on a monthly basis for the duration of the Project.

B. Provide Progress Schedule in adequate detail to allow Owner to monitor progress and to relate submittal processing to sequential activities of the Work.

C. Incorporate Contract Milestones into the schedule and show activities leading to achievement of these milestones.

D. Assume complete responsibility for maintaining the progress of the Work per the Progress Schedule submitted.

1.02 DOCUMENTATION

A. Submit the schedules to the Construction Manager. Send all documents in digital format for processing.

B. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.

C. Provide schedules, schedule updates and revisions to the Construction Manager in electronic format in its originating software and in Portable Document Format (PDF) as required by Section 01 33 00 “Document Management.”

D. Submit a preliminary Progress Schedule at the pre-construction conference.

E. Submit a detailed Progress Schedule at least 10 days prior to the first payment request.

F. Submit Progress Schedule updates monthly within 10 days after submitting Applications for Payment to indicate the progress made on the Project to the closing date for the Application for Payment. Failure to submit Progress Schedules will cause delay in the review and approval of subsequent Applications for Payment.

1.03 PROGRESS SCHEDULE REQUIREMENTS

A. Progress Schedule is to be in adequate detail to:

1. Ensure adequate planning, scheduling, and reporting during the execution of the Work;

2. Ensure the coordination of the Work of the Contractor and the various Subcontractors and Suppliers;

3. Monitor the progress of the Work; and

4. Evaluate the impact of proposed changes to the Contract Times and Project Schedule.

B. Provide personnel with 5 years’ minimum experience in scheduling construction work comparable to this Project. Prepare the Progress Schedule using acceptable scheduling software.

C. Provide the Progress Schedule in the form of a computer-generated critical path schedule which includes Work to be performed on the Project. It is intended that the Progress Schedule accomplish the following:

1. Give early warning of delays in time for correction.
2. Provide detailed plans for the execution of the Work in the form of future activities and events in sequential relationships.
3. Establish relationships of significant planned Work activities and provide a logical sequence for planned Work activities.
4. Provide continuous current status information.
5. Allow analysis of the Contractor's program for the completion of the Project.
6. Permit schedules to be revised when the existing schedule is not achievable.
7. Log the progress of the Work as it actually occurs.

D. Provide a time-scaled horizontal bar chart which indicates graphically the Work scheduled at any time during the Project. The chart is to indicate:

1. Complete sequence of construction by activity;
2. Identification of the activity by structure, location, and type of Work;
3. Chronological order of the start of each item of Work;
4. The activity start and stop dates;
5. The activity duration; and production rates used to determine the duration;
6. Successor and predecessor relationships for each activity;
7. A clearly indicated single critical path; and
8. Projected percentage of completion based on dollar value of the Work included in each activity as of the first day of each month.

E. Provide a Progress Schedule for Submittals:

1. Indicate the specific dates each document is to be delivered to the Construction Manager.
2. Allow a reasonable time to review each document, taking into consideration the size and complexity of the document, other documents being processed, and other factors that may affect review time.
3. Include time for revising the Shop Drawings and resubmitting the Shop Drawing for at least a second review.
4. Assume a 14-day review cycle for each time a Shop Drawing is submitted for review unless a longer period is indicated in the Contract Documents or provided by the Construction Manager.
5. Contractor is responsible for delays associated with additional time required to review incomplete or erroneous documents and for time lost when documents are submitted for products that do not meet specification requirements.

1.04 PROGRESS SCHEDULE REVISIONS

A. Revise the Progress Schedule if it appears that the schedule no longer represents the actual progress of the Work.

1. Submit a Plan of Action for schedule recovery if the Progress Schedule or earned value analysis indicates that the Project is more than 30 days behind schedule. The report is to include:

a. Number of days behind schedule;

b. Narrative description of the steps to be taken to bring the Project back on schedule; and

c. Anticipated time required to bring the Project back on schedule.

2. Submit a revised Progress Schedule indicating the action that the Contractor proposes to take to bring the Project back on schedule.

B. Revise the Progress Schedule to indicate any adjustments in Contract Times approved by a Modification.

1. Include a revised Progress Schedule with Change Proposals if a change in Contract Times is requested.

2. Construction Manager will deem any Change Proposal that does not have a revised Progress Schedule and request for a change in Contract Times as having no impact on the ability of the Contractor to complete the Project within the Contract Times.

C. Updating the Progress Schedule to reflect actual progress is not considered a revision to the schedule.

D. Applications for Payment will not be recommended for payment without a revised Progress Schedule and if required, the report indicating the Contractor's plan for bringing the Project back on schedule.

1.05 FLOAT TIME

A. Define float time as the amount of time between the earliest start date and the latest start date of a chain of activities on the construction schedule.

B. Float time is not for the exclusive use or benefit of either the Contractor or Owner.

C. Where several subsystems each have a critical path, the subsystem with the longest time of completion is the critical path and float time is to be assigned to other subsystems.

D. Schedule completion date must be the same as the Contract completion date. Time between the end of construction and the Contract completion date is float time.

1.06 MODIFICATION OF CONTRACT TIMES

A. Contract Times cannot be changed by the submission of a Progress Schedule. Contract Times can only be modified by a Change Order or Contract Amendment.

B. Submit a Change Proposal for any proposed change in Contract Times, and include justification for the change in accordance with the provisions of the Contract Documents.

1.07 NEAR-TERM LOOK AHEAD SCHEDULES

A. Provide a near-term look ahead schedule (NTLA Schedule) every 30 days, typically at periodic coordination meetings, using the form provided by the Construction Manager which shows the days of planned activity for the following:

1. Submittals to be provided and day of anticipated return;
2. Equipment and material deliveries;
3. Arrival and departure of key construction equipment; and
4. Activities for the Contractor and each Subcontractor.

B. Coordinate NTLA Schedule with Project Schedule. Submit a report with each NTLA Schedule identifying deviations from the Project Schedule.

C. Submit a report of near-term work planned in the previous NTLA Schedule that was delayed or not executed by marking actual activity on the previous near term look ahead schedule. Provide explanation of why planned work was not executed and plan to execute in the future and regain time lost.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 06 GRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish an adequate number of photographs of the Site to clearly depict the completed Project.

1. Provide aerial photographs of the completed Project from an angle and height to include the entire Site.
2. Provide a minimum of four different views.
3. Photograph a panoramic view of the entire Site.
4. Photograph all significant areas of completed construction.
5. Do not take completion photographs until all construction trailers, excess materials, trash, and debris have been removed.
6. Employ a professional photographer approved by the Construction Manager to photograph the Project.

B. Provide video recordings of the Site.

1. Record the condition of all existing facilities in or abutting the construction area (right-of-way) including streets, curb and gutter, utilities, driveways, fencing, landscaping, etc., prior the beginning of construction. Provide one copy of the dated and labeled recording to the Construction Manager before the start of construction. Provide additional recording as directed by the Construction Manager if the recording provided is not considered suitable for the purpose of recording pre-existing conditions.
2. Provide a video recording of the Site after the Project is complete and all construction trailers, excess materials, trash, and debris have been removed. Provide a 360-degree view of the Project from a consistent height and angle.
3. Format must allow photographic still shots to be extracted from the video recording.

C. All photographs and video recordings are to become the property of the Owner. Photographs or recordings may not be used for public or private publication or display without the written consent of the Owner.

1.02 DOCUMENTATION

A. Submit photographic documentation in accordance with Section 01 33 00 “Document Management.”

1.03 QUALITY ASSURANCE

A. Provide clear photographs and video recordings taken with proper exposure. View photographs and video recordings in the field and take new photographs or video recordings immediately if photos of an adequate print quality cannot be produced or video

quality is not adequate. Provide photographs with adequate quality and resolution to permit enlargements.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHS

A. Provide photographs in digital format with a minimum resolution of 1280x960, accomplished without a digital zoom.

B. Take photographs at locations acceptable to the Construction Manager.

C. Provide a digital copy of each photograph taken.

D. Identify each photograph with:

1. Name of the Project.
2. Date, time, location, and orientation of the exposure.
3. Description of the subject of photograph.

2.02 VIDEO RECORDING

A. Provide video recordings in digital format that can be played with Windows Media Player in full screen mode without loss of resolution.

B. Identify Project on video by audio or visual means.

C. Provide video with file size that does not exceed 1 GB.

D. Provide video resolution of at least 1080p.

E. The quality of the video must be adequate to determine the existing conditions of the construction area. Camera panning must be performed while at rest; do not pan the camera while walking or driving. Camera pans should be performed at intervals to clearly view the entire construction area.

F. Label the DVD with construction stationing. Stationing is to be annotated in the video.

G. The entire construction area recording must be submitted at once. Sections submitted separately will not be accepted.

H. Site components must be video recorded in an organized sequential order with major components identified.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 35 00 SPECIAL PROCEDURES

PART 1 - GENERAL

1.01 CONSTRUCTION SEQUENCE

A. Consider the sequences, duration limitations, and governing factors outlined in this Section to prepare the schedule for the Work.

B. Perform the Work not specifically described in this Section as required to complete the entire Project within the Contract Times.

1.02 CRITICAL OPERATIONS

A. The Owner has identified critical operations that must not be out of service longer than the designated maximum out of service time and/or must be performed only during the designated times. These have been identified in the table below:

Critical Operation	Max. Time Out of Operation	Hours Operation Can Be Shut Down	Liquidated Damages ($/hour)
JKWTP West High Service Pump Station	4 hours	7 AM – 8 PM	$500

B. Submit a written Plan of Action per Section 01 31 13 “Project Coordination” for approval for critical operations.

C. Before a shutdown, a coordination meeting is required between the Contractor, Owner Operations Staff, Engineer, and Construction Manager to discuss the plan of action and coordination locations of work.

D. Work affecting critical operations is to be performed on a 24-hour a day basis until Owner’s normal operations have been restored.

E. Provide additional manpower and equipment as required to complete the Work affecting critical operations within the allotted time.

F. At a minimum, the Contractor shall have all equipment and miscellaneous appurtenances at the project site before any shutdown will be allowed by the Owner.

G. Liquidated damages will be assessed if Work on critical operations is not completed within the time indicated.

1. This item is critical to the supply of drinking water to the City of Arlington and customer cities. All treatment processes are required to produce drinking water.

2. Loss of water treatment capabilities or pumping capabilities can subject the Owner to loss of revenue, additional operations cost, and fines from regulatory agencies.

3. Liquidated damages have been established for each critical operation.

H. Designated Critical Operations are described in more detail as follows:

1. West High Service Pump Station

a. The West High Service Pump Station must be in operation for the entire project except for short duration shutdowns of 4 hours. This plant must have the ability to pump high pressure discharge to the distribution system.

1.03 OWNER ASSISTANCE

A. The Owner will assist the Contractor in shut down and startup of the plant processes as required for the shutdown. The Contractor will be responsible for temporary bypass, bulkheads, plugs, etc. to allow work in the shutdown area.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Contractor may elect to provide temporary facilities, but it is not required for this project. The temporary facilities may include OPT's field office, Contractor's field offices, storage sheds, workshops, and other facilities needed to complete the Work.

B. Provide temporary utilities needed to support the operation of the facilities and construction activities.

C. Provide and maintain temporary project identification signs for Owner.

D. Provide temporary informational signs to identify key elements of construction and direct the flow of traffic.

E. Provide a weatherproof kiosk for display of permits and other notices required by Laws and Regulations.

1.02 QUALITY ASSURANCE

A. Inspect and test each utility before using facilities. Arrange for all required inspections and tests by regulatory agencies and obtain required certifications and permits for use of facilities.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Transport, unload, and set up all temporary buildings and utilities.

1.04 JOB CONDITIONS

A. Locate buildings and sheds at the Site as indicated or as approved by the OPT.

B. Prepare the Site by removing trees, brush, or debris and performing demolition or grubbing needed to clear a space adequate for the structures.

C. Provide Contractor's temporary facilities and utilities in time to avoid delays in the performance of the Work.

D. Provide and maintain temporary facilities and utilities.

E. Operate temporary facilities in a safe and efficient manner.

1. Restrict loads on utilities to operate within their designed or designated capacities.

2. Provide sanitary conditions. Prevent public nuisance or hazardous conditions from developing or existing at the Site.

3. Prevent freezing of pipes, flooding, or the contamination of water.

4. Maintain site security and protection of the facilities.

F. Remove temporary facilities and utilities when construction is complete, and removal is approved by the Construction Manager.

PART 2 - PRODUCTS – NOT REQUIRED

2.01 SIGN MATERIALS

A. Provide wood or metal signs in sound condition, structurally adequate to withstand wind and weather.

B. Provide 3/4-inch exterior grade A/D face veneer plywood with medium density overlay for sign surface.

C. Provide stainless-steel bolts, brackets, fasteners, and other hardware.

D. Provide exterior quality coatings.

2.02 OPT FIELD OFFICES

A. Provide and continuously maintain OPT's field office separate from Contractor's field office. Provide an office with a minimum nominal size of 12 feet by 56 feet.

1. Office and/or materials of construction may be new or slightly used but must be serviceable, adequate for the intended purpose, acceptable to the Construction Manager, and must not violate codes or regulations.

2. Offices are to be structurally sound, weather-tight, insulated and have floor raised above the ground. Brace and anchor offices to prevent movement.

3. Skirt around perimeter of structures with the same material as structure siding.

4. Divide the office into two separate spaces (two offices, restroom, and work area). Provide one 12-foot by 12-foot offices at both ends with full height walls and interior 3-foot by 6-foot-8-inch doors.

5. Provide an ADA compliant restroom with door in the center section of the office.

6. Provide vinyl or VCT tile on floors.

7. Provide outside doors with padlocks and door locks.

8. Provide operable, screened windows with locks.

9. Provide mounted boot brush / cleaner / scraper on porch at entrances.

B. Construct a wood porch with steps and a covered overhang at doors that ensures that rain will be completely diverted from doors. Provide wooden railing around porch and on the steps.

C. Provide electricity to the field office adequate to power equipment, appliances, and heating and cooling systems.

1. Provide adequate lighting for office environment using fluorescent light fixtures with lenses energized by wall switches. Provide separate switches just inside exterior doors for the main area, inside of offices and inside the restroom.

2. Provide outside security lighting.

3. Provide three duplex receptacles in each office and five duplex receptacles in remainder of building at locations designated by Construction Manager.

D. Provide an electric heating and cooling system for the field office capable of maintaining the following conditions:

1. Heat to a minimum of 75 deg. F inside when outside temperatures are 10 deg. F.
2. Cool to a minimum 72 deg. F inside temperature when outside temperatures are 105 deg. F.
3. Maintain relative humidity between 48 to 54 percent.

E. Provide fully plumbed indoor restroom with flush toilet, sink, hot water, mirror, and storage cabinet for paper goods. Connect fixtures to complete potable water, sanitary, and vent systems.

F. Provide an electric water cooler and a supply of bottled water.

G. Provide furnishings at the field office as follows:

Qty.	Furnishing
2	2’-6” x 5’-0” office desks with credenzas or built in desks
2	Fabric covered cushioned armchairs with swivel/tilt/roll capabilities
10	Folding chairs (Lifetime Commercial Grade white granite)
2	3’-0” x 8’-0” folding tables (Lifetime Commercial Grade white granite)
2	Legal size, four-drawer metal filing cabinets
2	6’' X 48” x 12” bookshelves
1	Full-size drafting/plan table
1	Plastic waste cans for each office
1	Large waste can each for open area and restroom

H. Provide internet service at the field office with the following features:

1. Minimum 40 Mbps download, 40 Mbps upload speed;
2. Maximum file transfer size of 100 MB; and
3. Unlimited email/storage size.

I. Provide wireless router for internet services with adequate range to reach all areas of the office.

J. Provide color copier with the following capabilities:

1. Provide service and maintenance agreement throughout the Project. Provide toner, paper supply for the duration of the Project, and other supplies as needed to operate the copier.
2. Ability to scan to email/file/folder.
3. Ability to print, sort and collate.
4. Produce up to 45 copies per minute in black and white.
5. Ability to scan and print in black and white, grayscale, or color.
6. Ability to auto feed and auto duplex.
7. Provide a minimum of two paper trays with 500-sheet capacity.

8. Reduction and enlargement capability with range from 25 to 400 percent.

9. Ability to scan, copy, and print up to 11 x 17 format.

K. Provide a fire extinguisher and commercially serviced first aid kit.

L. Furnish a microwave unit with a minimum cooking volume of 1.5 cubic feet.

M. Furnish a refrigerator/freezer with minimum storage capacity of 3.5 cubic feet.

N. Field office and furniture will remain the property of the Contractor.

O. Provide access to reserved parking spaces for six vehicles adjacent to the OPT's field offices. Provide a durable parking area surface to prevent erosion, mud, dust, or rutting caused by vehicles. Provide a minimum of 4 inches of flexible crushed limestone base material.

2.03 CONTRACTOR'S FIELD OFFICE

A. Furnish a field office of adequate size for Contractor's use.

B. Subcontractors may provide their own field offices only when space is available on the Site and the OPT agrees to its size, condition, and location.

2.04 TEMPORARY STORAGE BUILDINGS

A. Furnish storage buildings of adequate size to store any materials or equipment delivered to the Site that might be affected by weather.

2.05 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities at the Site for the entire duration of the Project. Always maintain these facilities in a clean and sanitary condition and comply with the requirements of the local health authority. On large sites, provide portable toilets at such locations so that no point at the Site will be more than 600 feet from a toilet.

B. Use these sanitary facilities. Do not use restrooms within existing or Owner-occupied buildings.

2.06 TEMPORARY HEAT

A. Provide heating devices needed to protect buildings during construction. Always provide fuel needed to operate the heating devices and attend the heating devices when they are in operation, including for overnight operations.

2.07 TEMPORARY UTILITIES

A. Provide the temporary utilities for administration, construction, testing, disinfection, and startup of the Work, including electrical power, water, and telephone. Pay all costs associated with furnishing temporary utilities.

1. Provide a source of temporary electrical power of adequate size for construction procedures. Provide electrical pole and service connections that comply with Laws and Regulations and the requirements of the power company.

2. Provide temporary water. Potable water may be purchased from the City of Arlington.

3. Provide telephone service to the Site and install telephones inside the Contractor's and OPT's field offices.

B. Provide power for construction and storage. Provide power to energize space heaters for stored electrical equipment.

2.08 WATER FOR CONSTRUCTION

A. Provide temporary water. Potable water may be purchased from the Owner by obtaining a water meter from the Owner and transporting water from a water hydrant. Non-potable water may be used for hydraulic testing of non-potable basins or pipelines. Include the cost of water in the Contract Price.

PART 3 - EXECUTION

3.01 LOCATION OF TEMPORARY FACILITIES

A. Locate temporary facilities in areas approved by the Construction Manager. Construct and install signs at locations approved by the Construction Manager. Install informational signs so they are clearly visible.

3.02 PROJECT IDENTIFICATION SIGNS

A. Arrange for a professional sign painter to paint and erect a sign for the Site in accordance with the sign information provided in the Contract Documents or provided by Owner. Sign will include identification of the OPT and Contractor (including appropriate logos, as required) and other Project information as determined by the Construction Manager. Paint sign on a 4-foot by 8-foot by 3/4-inch exterior grade plywood board. Frame plywood with 2 x 4 wood frame and mount on not less than two 4 x 4 posts. House plywood board in a channel routed 1/2-inch-deep in the 2 x 4 frame. Shoulder, glue, and screw corners.

3.03 TEMPORARY LIGHTING

A. Provide temporary lighting inside buildings once buildings are weatherproof.

B. Provide exterior security lighting.

C. Provide lighting that is adequate to perform Work within any space. Temporary lights may be removed once the permanent lighting is in service.

D. Provide portable flood lights at any time that Work will be performed outside the structure at night. Provide adequate lighting at any location Work is being performed.

3.04 DRINKING WATER

A. Provide all field offices with potable water. Provide a dispenser and cooling apparatus if bottled drinking water is provided.

B. Pay for water services and maintain daily.

3.05 REMOVAL OF TEMPORARY FACILITIES

A. Remove temporary buildings, sheds, and utilities at the conclusion of the Project and restore the Site to original condition or finished condition in accordance with the Drawings.

B. Remove informational signs upon completion of construction.

C. Remove project identification signs, framing, supports, and foundations upon completion of the Project.

END OF SECTION

01 57 00 TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, equipment, and incidentals necessary to construct temporary facilities to provide and maintain control over environmental conditions at the Site. Remove temporary facilities when no longer needed.

B. Construct temporary impounding works, channels, diversions, furnishing, and operation of pumps, installing piping and fittings, and other construction for control of conditions at the Site. Remove temporary controls at the end of the Project.

1.02 DOCUMENTATION

A. Provide Shop Drawings in accordance with Section 01 33 02 “Shop Drawings.”

B. Provide copies of notices, records, and reports required by the Contract Documents or Laws and Regulations as Product Data in accordance with Section 01 31 13 “Project Coordination.”

1.03 QUALITY ASSURANCE

A. Construct and maintain temporary controls with adequate workmanship using durable materials to provide effective environmental management systems meeting the requirements of the Contract Documents and Laws and Regulations. Use materials that require minimal maintenance to prevent disruption of construction activities while providing adequate protection of the environment.

B. Periodically inspect systems to determine that they are meeting the requirements of the Contract Documents.

1.04 POLLUTION CONTROL

A. Prevent the contamination of soil, water, or atmosphere by the discharge of noxious substances from construction operations. Provide adequate measures to prevent the creation of noxious air-borne pollutants. Prevent dispersal of pollutants into the atmosphere. Do not dump or otherwise discharge noxious or harmful fluids into drains or sewers, nor allow noxious liquids to contaminate public waterways in any manner.

B. Provide equipment and personnel and perform emergency measures necessary to contain any spillage.

1. Contain chemicals in protective areas and do not dump on soil. Dispose of such materials at off-site locations in an acceptable manner.

2. Excavate contaminated soil and dispose at an off-site location if contamination of the soil does occur. Fill resulting excavations with suitable backfill and compact to the density of the surrounding undisturbed soil.

a. Provide documentation to the Owner which states the nature and strength of the contaminant, method of disposal, and the location of the disposal site.

3. Comply with Laws and Regulations regarding the disposal of pollutants.

C. Groundwater or run-off water which has come into contact with noxious chemicals, sludge, or contaminated soil is considered contaminated. Do not allow contaminated water to enter streams or water courses, leave the Site in a non-contained form, or enter non-contaminated areas of the Site.

1. Construct temporary holding ponds or take other precautions and measures as required to contain the contaminated water and pump to a designated storage area.

2. Wash any equipment used for handling contaminated water or soil within contaminated areas three times with uncontaminated water prior to using such equipment in an uncontaminated area. Dispose of wash water used to wash such equipment as contaminated water.

1.05 EARTH CONTROL

A. Remove excess soil, spoil materials, and other earth not required for backfill. Control stockpiled materials to eliminate interference with Contractor and Owner's operations.

B. Dispose of excess earth off the Site. Provide written approval from the property owner for soils deposited on private property as Product Data per Section 01 31 13 "Project Coordination." Obtain approval of the OPT if this disposal impacts the use of Site or other easements.

1.06 AIR POLLUTION CONTROL

A. Air Pollution Watch Days:

1. Air Pollution Watch Days (APWD) may occur in the following times:

a. Typical Ozone Season: May 1 through October 31.

b. Critical Emission Time: 6:00 a.m. to 10:00 a.m.

2. Watch Days:

a. State or local environmental regulatory agencies, in coordination with the National Weather Service, may designate the following day as an APWD by 3:00 p.m. on the prior afternoon.

b. Begin work after 10:00 a.m. on designated APWD if work requires the use of heavy construction equipment for run times in excess of 1 hour prior to 10:00 a.m. Heavy construction equipment may be used prior to 10:00 a.m. if equipment is certified by EPA as "Low Emitting" or equipment burns Ultra Low Sulfur Diesel (ULSD), diesel emulsions, or alternative fuels such as CNG.

B. Obtain air permit for construction activities per requirements of Laws and Regulations.

1.07 TEMPORARY STORMWATER POLLUTION CONTROL

A. Provide temporary stormwater pollution control per Section 01 57 23 "Temporary Stormwater Pollution Control."

1.08 MANAGEMENT OF WATER

A. Manage water resulting from rains or ground water at the Site. Maintain trenches and excavations free of water at all times.

B. Lower the water table in the construction area by acceptable means if necessary to maintain a dry and workable condition at all times. Provide drains, sumps, casings, well points, and other water control devices as necessary to remove excess water.

C. Provide continuous operation of water management actions. Maintain standby equipment to provide proper and continuous operation for water management.

D. Ensure that water drainage does not damage adjacent property. Divert water into the same natural watercourse in which its headwaters are located, or other natural stream or waterway as approved by the Owner. Assume responsibility for the discharge of water from the Site.

E. Remove the temporary construction and restore the Site in a manner acceptable to the Construction Manager and to match surrounding material at the conclusion of the Work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide materials that comply with Laws and Regulations.

PART 3 - EXECUTION

3.01 CONSTRUCTING, MAINTAINING, AND REMOVING TEMPORARY CONTROLS

A. Construct temporary controls in accordance with Laws and Regulations.

B. Maintain controls in accordance with regulatory requirements where applicable or in accordance with the requirements of the Contract Documents.

C. Remove temporary control when no longer required, but before the Project is complete. Correct any damage or pollution that occurs as the result of removing controls while they are still required.

END OF SECTION

01 60 00 PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide products for this Project that comply with the requirements of this Section. Specific requirements of the detailed equipment specifications govern in the case of a conflict with the requirements of this Section.

B. Comply with applicable specifications and standards.

1.02 DOCUMENTATION

A. Provide documents in accordance with the Contract Documents.

1.03 QUALITY ASSURANCE

A. Design Criteria:

1. Provide products designed for structural stability and operational capability.

2. Provide members designed to withstand all loads imposed by installation, erection, and operation of the product without deformation, failure, or adversely affecting the operational requirements of the product. Size and strength of materials for structural members are specified as minimums only.

3. Design mechanical and electrical components for all loads, currents, stresses, and wear imposed by startup and normal operations of the equipment without deformation, failure, or adversely affecting the operation of the unit. Mechanical and electrical components specified for equipment are specified as the minimum acceptable for the equipment.

B. Coordination:

1. Provide coordination of the entire Project, including verification that structures, piping, and equipment components to be furnished and installed for this Project are compatible.

2. Determine that the equipment furnished for this Project is compatible with the requirements of the Contract Documents and with the equipment and materials furnished by others.

3. Provide electrical components for equipment that comply with all provisions of the Contract Documents.

4. Apply protective coatings and paints to equipment in the shop that are fully compatible with the final coatings to be field applied in accordance with the Contract Documents.

C. Adapting Substitute Products:

1. The Drawings and Specifications are prepared for the specified products. Make modifications to incorporate the products into the Project if a substitution is requested

for a product is and approved in accordance with Section 01 26 00 “Change Management.”

2. Do not provide a product with a physical size that exceeds the available space. Consideration may be given to the acceptance of these products or equipment if the Contractor assumes all costs necessary to incorporate the item and the OPT approves such revisions.

3. Coordinate electrical requirements for the products to be installed in the Project, including revisions in electrical equipment components wiring and other elements necessary to incorporate the component.

1.04 STANDARDS

A. The applicable industry standards referenced in the Specifications apply as if written here in their entirety.

B. Provide equipment manufactured using structural and miscellaneous fabricated steel conforming to the standards of the American Institute of Steel Construction, except where indicated otherwise.

1.05 WARRANTIES AND GUARANTEES

A. Normal warranty provisions are as stated in the General Conditions and Section 01 78 36 “Warranties and Service Agreements.”

B. Correct Defective Work under the provisions of the General Conditions.

C. Provide warranties and guarantees for periods as defined in the Contract Documents. Individual Sections of the Specifications may have more stringent warranty requirements than stated in the General Conditions. The most stringent warranty will apply in the event of conflicts within the Contract Documents.

D. The Contract Documents may require special warranties that guarantee performance at a specified capacity, power consumption, efficiency, or other operating parameter. Correct defects that prevent products from meeting the specified performance parameters. The requirements of the special warranty that guarantee performance will be satisfied when the specified performance parameters have been met for a period of 1 calendar year of operation, unless Owner elects to accept Defective Work under the provisions of the General Conditions.

E. The Contract Documents may require special warranties for periods extending beyond the one-year correction period specified in the General Conditions. The full warranty provisions and requirements for correction of Defective Work stated in the General Conditions apply throughout the extended warranty period.

F. Provide a warranty bond to provide the same protection as the Contractor's performance bond for extended special warranties. The warranty bond will become effective on the day the performance bond expires which is 1 year after the date of final payment per the General Conditions. The warranty bond will remain in effect until the extended warranty period has expired.

G. In the event that products are repaired, modified, or replaced under the warranty bond, then the warranty period will continue on the date of completion of these repairs for a

period of 6 months or until the end of the original warranty period, whichever is later. In no event will the warranty period extend more than 6 months beyond the end of the original warranty period.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide products according to normally accepted engineering and shop practices, except where a higher standard of quality is required by the Contract Documents.

B. Manufacture like parts of duplicate units to standard sizes and gages that are interchangeable.

C. Two or more items of the same kind are to be identical and made by the same Supplier.

D. Provide products suitable for the intended service.

E. Adhere to the equipment capacities, sizes, and dimensions indicated in the Contract Documents.

F. Do not use products for any purpose other than that for which they were designed.

G. Provide new products. Do not provide equipment that has been in service at any time prior to delivery except for testing in accordance with the Contract Documents.

H. Provide materials suitable for service conditions.

I. Provide iron castings that are tough, close grained gray iron free from blowholes, flaws, or excessive shrinkage and that conform to ASTM A48.

J. Design structural members for shock or vibratory loads.

K. Provide steel that is at least 1/4-inch-thick for all elements that will be submerged or subject to splashing all or part of the time during normal operation of the equipment. Chamfer or grind all edges to eliminate sharp exposed edges.

2.02 EQUIPMENT APPURTENANCES

A. Provide a safety guard covering all sides on belt or chain drives, fan blades, couplings, and other moving or rotating parts:

1. Fabricate safety guards from 16 US gauge or heavier galvanized or aluminum clad sheet steel or 1/2-inch mesh galvanized expanded metal;

2. Design guards for easy installation and removal;

3. Provide galvanized supports and accessories for each guard;

4. Provide stainless steel bolts and hardware; and

5. Provide safety guards designed to prevent the entrance of rain and dripping water in outdoor locations.

2.03 ANCHOR BOLTS

A. Provide suitable anchor bolts for each product.

B. Provide anchor bolts with templates or setting drawings in time to permit casting the anchor bolts in the concrete when concrete is placed.

C. Provide two nuts for each bolt.

D. Provide anchor bolts for products mounted on baseplates that are long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete. Bolts must be long enough to provide full nut engagement and leave three threads exposed. Housekeeping pads are not structural concrete.

E. Provide stainless steel anchor bolts, nuts, and washers.

2.04 SPECIAL TOOLS AND ACCESSORIES

A. Furnish tools, instruments, lifting and handling devices, and accessories necessary for proper maintenance and adjustment that are available only from the manufacturer or are not commonly available.

2.05 EQUIPMENT IDENTIFICATION PLAQUES

A. Provide a plaque for each piece of equipment in accordance with Section 40 05 53 “Identification for Process Piping and Equipment.”

2.06 LUBRICATION SYSTEMS FOR EQUIPMENT

A. Provide equipment lubricated by systems which:

1. Require attention no more frequently than weekly during continuous operation.

2. Do not require attention during startup or shut down.

3. Do not waste lubricants.

B. Provide lubricants to fill lubricant reservoirs and to replace lubricant consumed during testing, startup, and operation prior to acceptance of equipment by the Owner.

2.07 INSULATION OF PIPING

A. Insulate all piping on or related to equipment as required to prevent freezing under any condition. Insulate piping per the manufacturer’s written instruction or per Section 23 07 19 “HVAC Piping Insulation” whichever is more stringent.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment including equipment pre-selected or furnished by the Owner. Assume responsibility for proper installation, startup, and making the necessary adjustments so that the equipment is placed in proper operating condition per Section 01 75 00 “Starting and Adjusting.”

3.02 LUBRICATION

A. Lubricate all products provided or installed for this Project, including products furnished by the Owner, per the manufacturer's written recommendations until the product is accepted by the Owner.

END OF SECTION

01 64 00 OWNER-FURNISHED GOODS AND SPECIAL SERVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Accept the transfer of Owner's pre-purchased Goods and Special Services defined in Paragraph 2.01 for installation.

B. Receive, install, and place Goods in operation in accordance with the Contract Documents and the associated agreement and contract documents for Goods and Special Services.

C. Provide Special Services in accordance with the Contract Documents and the associated agreement and contract documents for Goods and Special Services.

D. Provide documentation required by the Contract Documents and the contract documents for the pre-purchase of Goods and Special Services.

E. The contract documents for the pre-purchase of Goods and Special Services are included in referenced appendices.

1.02 DOCUMENTATION

A. Owner will provide documentation of the Transfer of Owner Furnished Goods and Special Services listed in Paragraph 2.01 using forms provided by the Construction Manager. These forms will fix the date for transfer of responsibilities for the receipt, storage, and installation of the Goods and provision of Special Services in accordance with the Contract Documents and the contract documents for the Goods and Special Services.

B. Owner will provide Shop Drawings prepared by the Seller.

C. Owner will provide operation and maintenance manuals prepared by the Seller.

D. Provide Equipment Installation Reports as required by Section 01 75 00 "Starting and Adjusting."

E. Provide other documentation required regarding the Goods and Special Services per the requirements of Section 01 33 00 "Document Management."

1.03 QUALITY ASSURANCE

A. Inspect the condition of all equipment accepted for installation and promptly advise the Construction Manager in writing of defects or damage.

B. Owner will provide through Seller the services of the Seller's representative to assist in installation of the equipment in accordance with Section 01 75 00 "Starting and Adjusting" and the contract documents for the pre-purchase of Goods and Special Services included in the referenced appendices.

PART 2 - PRODUCTS

2.01 OWNER-PURCHASED GOODS AND SPECIAL SERVICES

A. Owner has or will purchase and provide the following Goods and Special Services to the Contractor:

Item	Description	Seller	Specification

B. Products are described in the referenced appendices. Obtain clarification from the Construction Manager in the case of a disagreement between the above list and those specified elsewhere in the Contract Documents.

C. Assume responsibilities for coordination, installation, and startup of Owner-provided products as for products selected and purchased by the Contractor.

D. Payment for the product will be made directly by the Owner per the agreement between Owner (as Buyer) and Seller.

E. Include all other costs associated with the installation, startup, and initial operation of the product in the Contract Price.

PART 3 - EXECUTION

3.01 GENERAL

A. Arrange for delivery of the equipment to be furnished and furnish personnel and equipment as needed to carefully unload the items and either store them or set them in place.

B. Provide the labor, tools, equipment, and appurtenances necessary to inspect, install, and place in operating conditions all Goods pre-purchased by the Owner or pre-selected and assigned to the Contractor.

C. Assemble equipment disassembled for shipping. Determine the extent of assembly that will be required and include the cost of this assembly in the Contract Price.

D. Furnish all incidental items not supplied with the Goods that may be required for complete installation. Include the cost for these items in the Contract Price.

E. Owner will provide through Seller the services of the manufacturer's representative to assist in installation of the equipment in accordance with the specifications included in appendices and Section 01 75 00 "Starting and Adjusting." Schedule the representative to be available when needed to assist and instruct in the proper installation and adjustment of the equipment. All Work and adjustments must be done in accordance with the manufacturer's recommendations and instructions of the manufacturer's representative.

F. Owner will provide through Seller installation, documentation, and training as required in the contract documents for the pre-selected or pre-purchased equipment and as required by these Contract Documents.

END OF SECTION

01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Comply with requirements of the General Conditions and specified administrative procedures in closing out the Contract.

1.02 DOCUMENTATION

A. Submit affidavits and releases on forms provided by the Construction Manager.

1.03 SUBSTANTIAL COMPLETION

A. The following requirements must be met for the Project or a designated portion of the Work to be Substantially Complete per the General Conditions:

1. Work must be fully functional and able to operate in accordance with the Contract Documents without special or extraordinary efforts on the part of the Owner.

2. Performance Acceptance Testing (PAT) must be complete and indicated compliance with the requirements of the Contract Documents.

3. Operation and maintenance manuals must be approved and operator training conducted to allow the Owner to assume responsibility for operations.

B. Conduct inspections with superintendent, Subcontractors, and Suppliers for the Work or a designated portion of the Work prior to calling for a Substantial Completion inspection by the OPT. Create a list of deficiencies in the Work that must be completed for the Project to qualify for Substantial Completion. Review the list with the Construction Manager or the designated member of the OPT. The Construction Manager or the designated member of the OPT may assist the Contractor with this effort; however, it is the Contractor's responsibility to create and manage this list of deficiencies until corrections are made.

C. Correct the identified deficiencies prior to calling for a Substantial Completion inspection.

D. Notify the Construction Manager that the Work or a designated portion of the Work is Substantially Complete per the General Conditions. Include a list of the items remaining to be completed or corrected before the Project will be considered for Final Completion.

E. OPT will visit the Site to observe the Work within a reasonable time after notification is received to determine the status of the Project.

F. Construction Manager will notify the Contractor that the Work is either Substantially Complete or that additional Work must be performed before the Project will be considered Substantially Complete.

1. Construction Manager will notify the Contractor of items that must be completed before the Project will be considered Substantially Complete.

2. Correct the noted deficiencies in the Work.

3. Notify the Construction Manager when the items of Work in the Construction Manager's notice have been completed.

4. OPT will revisit the Site and repeat the process.

5. Construction Manager will issue a Certificate of Substantial Completion to the Contractor when the OPT considers the Project to be Substantially Complete. The certificate will include a tentative list of items to be corrected before Final Payment will be recommended.

6. Review the list and notify the Construction Manager of any objections to items on the list within 10 days after receiving the Certificate of Substantial Completion.

1.04 TRANSFER OF UTILITIES

A. Transfer utilities to the Owner when the Certificate of Substantial Completion has been issued.

B. Submit final meter readings for utilities and similar data as of the date the Owner occupied the Work.

1.05 CLOSEOUT REQUIREMENTS

A. Provide the following before Final Completion:

1. Record Documents per Section 01 31 13 “Project Coordination”;

2. Keys and keying schedule;

3. Warranties, bonds, and service agreements;

4. Equipment Installation Reports;

5. Shop Drawings, Product Data, operation and maintenance manuals, and other documentation required by the Contract Documents;

6. Specified spare parts and special tools;

7. Certificates of occupancy, operating certificates, or other similar releases required to allow the Owner unrestricted use of the Work and access to services and utilities;

8. Evidence of continuing insurance and bond coverage as required by the Contract Documents; and

9. Final videos and photographs per Section 01 33 06 “Graphic Documentation.”

1.06 WARRANTIES, BONDS, AND SERVICES AGREEMENTS

A. Provide warranties, bonds, and service agreements required by Section 01 33 00 “Document Management” or by the individual Sections of the Specifications.

B. The date for the start of warranties, bonds, and service agreements is established per the General Conditions.

C. Compile warranties, bonds, and service agreements and review these documents for compliance with the Contract Documents.

1. Each document is to be signed by the respective Supplier or Subcontractor.

2. Each document is to include:

a. The product or Work item description;

b. The firm name, with the name of the principal, address, and telephone number;

c. Scope of warranty, bond, or services agreement;

d. Date, duration, and expiration date for each warranty bond and service agreement;

e. Procedures to be followed in the event of a failure; and

f. Specific instances that might invalidate the warranty or bond.

D. Submit digital copies of the documents to the Construction Manager for review.

E. Submit warranties, bonds, and services agreements within 10 days after equipment or components placed in service.

1.07 FINAL COMPLETION

A. Conduct inspections with Superintendent, Subcontractors, and Suppliers prior to calling for a Final Completion inspection by the OPT. Create a list of deficiencies in the Work that must be completed for the Project to qualify for the Final Completion inspection. Review the list with the Construction Manager or the designated member of the OPT. The Construction Manager or the designated member of the OPT may assist the Contractor with this effort; however, it is the Contractor's responsibility to create and manage this list of deficiencies until corrections are made.

B. Identify, list, and correct deficiencies prior to calling for a Final Completion inspection. The Project at the call for Final Completion represents the Contractor's interpretation of a project completed in conformance with the Contract Documents and reflects the Contractor's representation of a quality project meeting the Owner's expectations.

C. Notify the Construction Manager when:

1. Work has been completed and complies with the Contract Documents;

2. Equipment and systems have been tested per the Contract Documents and are fully operational;

3. Final operation and maintenance manuals have been provided to the Owner and all operator training has been completed;

4. Specified spare parts and special tools have been provided;

5. Work is complete and ready for final inspection;

6. Final documentation for all outstanding Modifications and Claims (other than those listed on the Certificate of Final Completion) have been processed and are ready for incorporation into the final Application for Payment; and

7. Closeout requirements in Paragraph 1.05 have been completed.

D. OPT will visit the Site to determine if the Project is complete and ready for final payment within a reasonable time after the notice is received.

E. Construction Manager will notify the Contractor that the Project is complete or will notify the Contractor that Work is Defective.

F. Take immediate steps to correct Defective Work. Notify the Construction Manager when Defective Work has corrected. OPT will visit the Site to determine if the Project is complete and the Work is acceptable. Construction Manager will issue a Certificate of Final Completion to the Contractor when the Project is complete or will notify the Contractor that Work is Defective.

G. Submit the request for final payment with closeout documentation described in Paragraph 1.06 if notified that the Project is complete, and the Work is acceptable.

1.08 REINSPECTION FEES

A. Owner may impose a set-off against the Application for Payment in accordance with the General Conditions to compensate the OPT for additional visits to the Project if additional Work is required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 74 23 FINAL CLEANING

PART 1 - GENERAL

1.01 SUMMARY

A. Perform a thorough cleaning of the Site, buildings, or other structures prior to Owner occupancy of the buildings, and prior to Final Completion. Leave the Project clean and ready for occupancy.

1.02 DOCUMENTATION

A. Provide data for maintenance per Section 01 33 04 “Operation and Maintenance Data.”

1.03 QUALITY CONTROL

A. Use experienced workmen or professional cleaners for final cleaning.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Furnish the labor and products needed for cleaning and finishing as recommended by the manufacturer of the surface material being cleaned.

B. Use cleaning products only on the surfaces recommended by the Supplier.

C. Use only those cleaning products which will not create hazards to health or property, and which will not damage surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

A. Thoroughly clean the entire Site and make ready for occupancy.

1. Remove construction debris, boxes, and trash from the Site.
2. Remove construction storage sheds and field offices.
3. Restore grade to match surrounding condition and remove excess dirt.
4. Sweep all drives and parking lots clean of dirt and debris. Use water trucks or hose down paved site to like new appearance.

B. Clean floors and inspect for damage.

1. Remove oil, grease, paint drippings, and other contaminants from floors, then mop repeatedly until thoroughly clean. Replace damaged flooring.
2. Clean resilient flooring with an approved cleaner and provide one coat of liquid floor polish as recommended by the flooring manufacturer. Polish to a buffed appearance with powered floor buffer.
3. Vacuum all carpets with powered floor sweeper to remove dirt and dust. Remove glue or other substances from nap of carpet.

C. Clean and polish inside and outside glass surfaces. Wash with window cleaner and water, apply a coat of high-quality glass polish, and wipe clean. Do not scratch or otherwise mar glass surfaces.

D. Clean wall surfaces to remove dirt or scuff marks. Remove excess adhesive along top edges of wall base. Remove adhesive from surfaces of vinyl wall coverings.

E. Align ceiling tile to fit properly in grid and replace cracked or damaged tile. Remove smear marks and other dirt from tile and clean surface of grid system.

F. Spot paint nicks and other damage. Repaint the wall from inside corner to inside corner if spot-painting does not blend into the existing color and texture of the surrounding surfaces. Touch up damaged surfaces on factory finished equipment using special paint furnished by the manufacturer.

G. Clean plumbing fixtures, valves, and trim. Clean toilet seats and covers. Remove labels and adhesive from fixtures. Remove floor drains and clean baskets or buckets. Polish strainers and exposed chrome or brass.

H. Remove dirt, oil, grease, dust, and other contaminants from floors, equipment, and apparatus in mechanical and electrical rooms.

I. Clean and polish ceramic tile floors and wall surfaces to remove mildew or other stains. Tuck point defective joints.

J. Inspect exterior painted surfaces. Spot paint any damaged surfaces.

K. Clean permanent filters and replace disposable filters on heating, ventilating, and air conditioning systems. Clean ducts, blowers, and coils if units were operated without filters during construction.

L. Clean roof areas of debris; flush roof drainage systems with water until clear.

M. Broom clean exterior paved surfaces and rake clean other surfaces of the grounds.

N. Clean and polish all electrical equipment and exposed conduits. Remove paint overspray. Provide a blemish free appearance on all exposed equipment and conduits.

END OF SECTION

01 75 00 STARTING AND ADJUSTING

PART 1 - GENERAL

1.01 SUMMARY

A. Provide step-by-step procedures for starting provided systems, including equipment, pumps, and processes.

B. Provide pre-startup inspections by equipment manufacturers.

C. Place each system in service and operate the system to prove performance and to provide for initial correction of defects in workmanship, calibration, and operation.

D. Provide for initial maintenance and operation.

E. Include costs for starting and adjusting provided by manufacturer's representative in the Cost of Work for the equipment package.

F. Owner will provide chemicals, if any, required for continued operations.

1.02 STANDARDS

A. Comply with the specified standards associated with the testing or startup of equipment.

1.03 DOCUMENTATION

A. Provide the following documents in accordance with Section 01 33 00 "Document Management":

1. A Plan of Action for testing, checking, and starting equipment as Product Data per Section 01 31 13 "Project Coordination."

2. Equipment Installation Reports on the form provided by the Construction Manager certifying that the equipment and related appurtenances have been thoroughly examined and approved for startup and operation.

3. Operation and maintenance manuals per Section 01 33 04 "Operation and Maintenance Data." Preliminary operation and maintenance data must be approved before installation, testing, and initial operation of equipment or providing training required by Section 01 79 00 "Training of Operation and Maintenance Personnel."

1.04 SPECIAL JOB CONDITIONS

A. Do not start or test any equipment until the complete unit has been installed and thoroughly checked.

B. Provide the services of a qualified representative of the manufacturer to attend the tests and startup procedures as required by this Section.

C. Do not start or test any equipment until the preliminary operation and maintenance manual per Section 01 33 04 "Operation and Maintenance Data" has been approved.

PART 2 - PRODUCTS

2.01 TESTING INSTRUMENTATION

A. Provide new instrumentation and testing devices needed to conduct tests for maintenance and operation as recommended in the operation and maintenance manuals. This equipment is to become the property of the Owner and transferred in good working order as a spare part at Substantial Completion. This equipment is to be calibrated and ready for use during the startup procedure and for training provided in accordance with Section 01 79 00 “Training of Operation and Maintenance Personnel.”

PART 3 - EXECUTION

3.01 SERVICES OF MANUFACTURER’S REPRESENTATIVES

A. Provide the services of experienced and technically competent representatives of the manufacturer for inspections, tests, supervision of installation, training, and assistance with placing equipment in operation.

B. Perform installation, adjustment, and testing of the equipment under the direct supervision of the manufacturer’s representative where specified. Certify that the equipment and related appurtenances have been thoroughly examined and approved for startup and operation in the Equipment Installation Reports.

C. Provide on-site services as necessary for proper and trouble free operation of the equipment.

3.02 INSPECTION AND STARTUP

A. Inspect equipment prior to placing any equipment or system into operation. Make adjustments as necessary for proper operation. Do not start or test any apparatus until the complete unit has been installed and thoroughly checked.

1. Check for adequate and proper lubrication.
2. Determine that parts or components are free from undue stress from structural members, piping, or anchorage.
3. Adjust equipment for proper balance and operations.
4. Determine that vibrations are within acceptable limits.
5. Determine that equipment operates properly under full load conditions.
6. Determine that the equipment is in true alignment.
7. Ensure that the proper procedure is employed in startup of systems.

3.03 STARTING REQUIREMENTS

A. Refer to the individual Specification Sections for specific startup procedures or other requirements.

3.04 INITIAL OPERATION

A. Start, test, and place equipment and systems into operation for 30 days to allow the OPT to observe the operation and overall performance of the equipment and to determine that controls function as intended.

B. Operate equipment which is used on a limited or part-time basis in the presence of the OPT for a period long enough to demonstrate that controls function as specified.

C. Perform acceptance test as specified in individual Specification Sections. Demonstrate that equipment and systems meet the specified performance criteria.

D. Equipment and systems may be considered as substantially complete at the end of this initial operation period if the equipment is placed in continuous beneficial use by the Owner, unless specifically stated otherwise in the individual equipment Specifications.

3.05 INITIAL MAINTENANCE

A. Maintain equipment in accordance with the operation and maintenance manuals until Project is substantially complete and provisions have been made by the Owner for accepting responsibility for equipment operation in accordance with the General Conditions.

B. Service equipment in accordance with the operation and maintenance manuals immediately before releasing the equipment to the Owner.

END OF SECTION

SECTION 01 75 11 CHECKOUT AND STARTUP PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall initially start up and place equipment and systems installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
   2. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
   3. Provide chemicals, lubricants, and other required operating fluids.
   4. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.
   5. General activities by CONTRACTOR include the following:
      a. Cleaning, as required under other provisions of the Contract Documents.
      b. Removing temporary protective coatings.
      c. Flushing and replacing lubricants, where required by manufacturer.
      d. Lubrication.
      e. Checking shaft and coupling alignments and resetting where required.
      f. Checking and setting motor, pump, and other equipment rotation, safety interlocks, and belt tensions.
      g. Checking and correcting (as necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
      h. Performing all adjustments required.

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 furnish sufficient personnel to assist CONTRACTOR in starting up equipment, but responsibility for proper operation is CONTRACTOR's.
   4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to ENGINEER.
   5. Startup of heating equipment, air conditioning equipment, and other equipment that provides cooling or other temperature control, and systems is dependent upon the time of year. Return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate systems.
   6. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by CONTRAC-TOR in accordance with Section 01 78 23, Operations and Maintenance Data.

C. OWNER's Assumption of Responsibility for Equipment and Systems:

1. OWNER will assume responsibility for the equipment upon Substantial Completion, unless otherwise mutually agreed upon by OWNER and CONTRACTOR or as documented in the certificate of Substantial Completion.
2. Before turning over to OWNER responsibility for operating and maintaining system or equipment CONTRACTOR shall:
    a. Provide training of operations and maintenance personnel in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
    b. Complete performance of equipment and system field quality control testing in accordance with the Contract Documents, to the extent possible.
    c. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
    d. Obtain from ENGINEER final certificate of Substantial Completion for either entire Work or the portion being turned over to OWNER.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:
    1. Certifications:
        a. Supplier's certification of installation in accordance with Paragraph 3.1.B of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SERVICES OF SUPPLIER

A. When specified, furnish services of competent, qualified representatives of material and equipment manufacturers, including supervising installation, adjusting, checkout, startup, and testing of materials and equipment.

B. Certification:
    1. When services by Supplier are required at the Site, within 14 days after first test operation of equipment, submit to ENGINEER a letter from Supplier, on Supplier's letterhead, stating that materials and equipment are installed in accordance with Supplier's requirements and installation instructions, and in accordance with the Contract Documents.
    2. In lieu of Supplier letter, submit completed form attached to this Section.
    3. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.

3.2 MINIMUM STARTUP REQUIREMENTS

A. Bearings and Shafting:
    1. Inspect for cleanliness, and clean and remove foreign matter.
    2. Verify alignment.
    3. Replace defective bearings and those that operate in a rough or noisy manner.
    4. Grease as necessary, in accordance with manufacturer's recommendations.

B. Drives:
   1. Adjust tension in V-belt drives and adjust vari-pitch sheaves and drives for proper equipment speed.
   2. Adjust drives for alignment of sheaves and V-belts.
   3. Clean and remove foreign matter before starting operation.

C. Motors:
   1. Check each motor for comparison to amperage nameplate value.
   2. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.

D. Pumps:
   1. Check glands and seals for cleanliness and adjustment before running pump.
   2. Inspect shaft sleeves for scoring.
   3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
   4. Verify that piping system is free of dirt and scale before circulating liquid through pump.

E. Valves:
   1. Inspect manual and automatic control valves, and clean bonnets and stems.
   2. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
   3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
   4. Replace packing on valves that continue to leak.
   5. Remove, correct, and replace bonnets that leak.
   6. After cleaning, coat packing gland threads and valve stems with surface preparation of “Molycote” or “Fel-Pro”.

F. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.

G. Pipe Joints and Other Connections:
   1. Tighten flanges and other pipe joints after system has been placed in operation.
   2. Replace gaskets that show signs of leakage after tightening.
   3. Inspect all joints for leakage.
   4. Promptly remake each joint that appears to be faulty; do not wait for rust other corrosion to form.
   5. Clean threads on both parts, and apply compound and remake joints.

H. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.

I. Open steam traps and air vents, where used, and remove operating elements. Clean thoroughly, replace internal parts, and place back into operation.

J. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.

K. Set and calibrate draft gauges of air filters and other equipment.

L. Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment where needed.

M. Check each electrical control circuit to verify that operation complies with the Contract Documents.

N. Inspect each pressure gauge, thermometer, and other instruments for calibration. Replace items that are defaced, broken, or that read incorrectly.

O. Repair damaged insulation.

P. Excess Gasses and Fluids:
   1. Vent gasses trapped in systems.
   2. Verify that liquids are drained from all parts of gas or air systems.

3.3 ATTACHMENTS

A. The attachment listed below, following this Section's "End of Section" designation, is a part of this Specification Section.
   1. Supplier's Installation Certification Form (one page).

+ + END OF SECTION + +

SUPPLIER'S INSTALLATION CERTIFICATION

Contract No. and Name: _____

Equipment Specification Section: _____

Equipment Name:

Contractor:

Manufacturer of Equipment: _____

The undersigned Supplier of the equipment or system described above hereby certifies that Supplier has checked the installation of the equipment or system and that the equipment or system, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations and the Contract Documents, and that the trial operation of the equipment or system has been satisfactory.

Comments:

Date Supplier Name (print)

Signature of Supplier

Date Contractor Name (print)

Signature of Contractor

01 78 36 WARRANTIES AND SERVICE AGREEMENTS

PART 1 - GENERAL

1.01 WARRANTY REQUIREMENTS

A. Provide products for this Project that comply with the requirements of this Section.

1.02 WARRANTIES AND GUARANTEES

A. Guarantee and warrant products furnished by the Contractor against:

1. Faulty or inadequate design;
2. Improper assembly or erection;
3. Defective workmanship or materials; and
4. Leakage, breakage, or other failure.

B. Guarantee and warrant the products installed under this Contract, including Goods furnished by the Owner, against leakage, breakage, or other failure due to improper assembly or erection and against improper installation of the equipment. The correction period is as defined in the General Conditions. Individual Specification Sections may have more stringent warranty requirements than those stated in the General Conditions. The most stringent warranty will be provided in the event of conflicts.

C. Provide all required warranties, guarantees, and related documents with the Shop Drawing. The effective date of warranties and guarantees will be the date of Substantial Completion.

D. Include an additional copy of equipment warranties in operation and maintenance manuals.

E. Provide a copy of all warranties in a separate document in accordance with Section 01 70 00 “Execution and Closeout Requirements.”

1.03 EXTENDED WARRANTIES

A. Extended Warranties are defined as any guarantee of performance for the product or system beyond the one-year correction period described in the General Conditions.

B. Issue the warranty certificate in the name of the Owner.

C. Provide a warranty bond for Extended Warranties as required by the individual Specification Sections.

1.04 SERVICE AGREEMENTS

A. Provide Extended Service Agreements (ESA) and related documents with the Shop Drawing. An Extended Service Agreement is a contract between the Owner and an approved Subcontractor or Supplier to provide service and or maintenance beyond that required to fulfill requirements for warranty repairs or to perform routine maintenance for a definite period beyond the one-year correction period specified in the General Conditions.

B. Requirements for the Extended Service Agreement are described in the Specification Sections for each piece of equipment or system requiring an Extended Service Agreement.

C. Enter into a contract with the service provider and assign the service contract to the Owner on the date of Substantial Completion. Once assigned to the Owner, Contract requirements for the Extended Service Agreement will be complete and will not extend the Contract between the Owner and Contractor.

D. Owner may require that a performance bond be provided for the Extended Service Agreement. Provide a separate bond meeting the same requirements as those for the Contractor's performance bond if required. The bond will be in the amount of the Extended Service Agreement.

E. Include an additional copy of Extended Service Agreements in operation and maintenance manuals.

F. Provide a copy of Extended Service Agreements in a separate document in accordance with Section 01 70 00 "Execution and Closeout Requirements."

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 79 00 TRAINING OF OPERATION AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.01 SUMMARY

A. Provide services of Supplier's operation and maintenance training specialists to instruct Owner's personnel in recommended operation and maintenance procedures for equipment furnished. Details for training may be established in the specifications for that equipment.

B. Provide a combination of classroom and hands on training.

C. Training may be conducted at Contractor's or Supplier's facilities provided Contractor pays for travel, lodging, and per diem costs of the Owner.

D. Record training sessions on video and submit to the Owner on DVD disk in MPEG-4 format for Owner's later use in instructing Owner's personnel. Include this recording as part of the final operation and maintenance manual. Provide legal releases or pay additional fees required to allow training by the manufacturer to be recorded.

E. Include the cost for training and startup in the Cost of the Work for each equipment package.

1.02 DOCUMENTATION

A. Provide documentation in accordance with Section 01 33 00 "Document Management" and include:

1. Equipment Installation Reports in accordance with Section 01 75 00 "Starting and Adjusting" on forms provided by the Construction Manager;

2. A lesson plan for training in accordance with Paragraph 3.01.C;

3. Credentials of Supplier's proposed operation and maintenance instructors demonstrating compliance with requirements of Paragraph 1.04; and

4. Operation and maintenance manuals per Section 01 33 04 "Operation and Maintenance Data." Preliminary operation and maintenance data must be approved before installation, testing, and initial operation of equipment or providing training required by the Section.

1.03 SCHEDULING OF TRAINING

A. Coordinate training services with startup and initial operation of equipment on days and times Owner is available.

B. Training may be required outside of normal business hours to accommodate schedules of operation and maintenance personnel.

C. Provide training of Owner's personnel after acceptable preliminary operation and maintenance manuals have been approved.

D. Coordinate training with equipment startup and testing and availability of Owner's personnel.

E. Provide a proposed training schedule for review and acceptance by OPT showing all training required in the Contract Documents. Demonstrate compliance with specified training requirements relative to number of hours of training, number of training sessions, and scheduling.

F. Submit initial training schedule at least 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with OPT's comments, no later than 30 days prior to starting the first training session.

G. Owner reserves the right to modify personnel availability for training in accordance with process or emergency needs.

H. Schedule for training is to be approved by Owner.

1. Schedule training and startup operations for no more than one piece of equipment or system at a time.

2. Owner may require re-scheduling of training if operations personnel are not available for training on a scheduled date.

3. Provide a minimum of 2 weeks' notice if training must be rescheduled.

4. Training is to be limited to 24 hours per week.

5. Time required for training is to be included in the development of the Project schedule.

I. Schedule and coordinate training for equipment or systems which depend upon other equipment or systems for proper operation so that trainees can be made familiar with the operation and maintenance of the entire operating system.

1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Manufacturer's instructors must be factory-trained by the equipment manufacturer.

B. Instructors must have knowledge of the theory of operation and practical experience with the equipment or system.

C. Instructors must be proficient and experienced in conducting training of the type required and must have successfully conducted similar training courses.

D. Qualifications of instructors are subject to acceptance by OPT. Provide services of replacement instructor with acceptable qualifications if OPT does not accept qualifications of proposed instructor. Include each instructor's résumé and specific details of instructor's operating, maintenance, and training experience relative to the specific equipment for which instructor will provide training to demonstrate their qualifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 OPERATOR TRAINING

A. Provide classroom and hands-on training of the care and operation of the equipment to the Owner's personnel.

B. Provide training in adequate detail to ensure that the trainees who complete the program will be qualified and capable of operating and maintaining the equipment, products, and systems provided.

C. Provide a training plan that indicates the schedule and sequence of the training programs. The training plan is to include for each course:

1. Number of hours for the course;
2. Agenda and narrative description, including the defined objectives for each lesson;
3. Draft copy of training handbooks;
4. A descriptive listing of suggested reference publications;
5. Audio-visual equipment required for training; and
6. Type and number of tools or test equipment required for each training session.

D. Provide and use training aids to complement the instruction and enhance learning.

1. Provide training handbooks for use in both the classroom and the hands-on phases of training for each course.
2. Instructional materials must include references to the operation and maintenance manuals and identify and explain the use of the manual.
3. Provide a copy of all audio/visual training materials used in the presentations to the Owner.

E. Operations training is to include:

1. Orientation to provide an overview of system/subsystem configuration and operation;
2. Terminology, nomenclature, and display symbols;
3. Operations theory;
4. Equipment appearance, functions, concepts, and operation;
5. Operating modes, practices, and procedures under normal, diminished, and emergency conditions;
6. Startup and shutdown procedures;
7. Safety precautions;
8. On-the-job operating experience for monitoring functions, supervisory, or command activities. Include functions and activities associated with diminished operating modes, failure recognition, and responses to system/subsystem and recovery procedures; and
9. Content and use of operation and maintenance manuals and related reference materials.

F. Provide training for performing on-site routine, preventive, and remedial maintenance of the equipment or system. Maintenance training is to include:

1. Orientation to provide an overview of system/subsystem concept, configuration, and operation;
2. Operations theory and interfaces;

3. Instructions necessary to ensure a basic theoretical and practical understanding of equipment appearance, layout, and functions;
4. Safety precautions;
5. Use of standard and special tools and test equipment;
6. Adjustment, calibration, and use of related test equipment;
7. Detailed preventive maintenance activities;
8. Troubleshooting, diagnostics, and testing;
9. Equipment assembly and disassembly;
10. Repair and parts replacement;
11. Parts ordering practices and storage;
12. Failure and recovery procedures;
13. Cabling and/or interface connectors;
14. Content and use of operation and maintenance manuals and related reference materials;
15. Procedures for warranty repairs;
16. Lubrication; and
17. Procedures, practices, documentation, and materials required to commence system maintenance.

G. Provide training for the equipment listed in the table below. The table indicates the minimum acceptable training time. Provide additional hours of training if required to meet the training objectives described in this Section.

Specification Section	Equipment/System Description	Min. Hours
43 21 13.33	Vertical Lineshaft Pumps	4

END OF SECTION

03 11 00 CONCRETE FORMING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete forming. The Work also includes:
      a. Designing forming systems in accordance with requirements of ACI 347 and the Contract Documents.
      b. Providing forming to accommodate the Work under this and other Sections and building into forming items such as sleeves, anchorage devices, inserts, pipe embedments, reinforcing, and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before concrete forming Work.
   2. Coordinate forming Specifications with requirements for finished surfaces specified in Section 03 30 00, Cast-In-Place Concrete.

C. Related Sections:
   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 30 00, Cast-In-Place Concrete.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
   2. ACI 301, Specifications for Structural Concrete.
   3. ACI 347, Guide to Formwork for Concrete.
   4. ASTM C805/C805M, Test Method for Rebound Number of Hardened Concrete.
   5. ASTM C1074, Practice for Estimating Concrete Strength by the Maturity Method.
   6. NIST PS 1, Structural Plywood.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. CONTRACTOR or formwork Supplier shall retain a registered professional engineer legally qualified to practice in the same state as the Site. The Professional engineer shall have at least five years of experience designing formwork and falsework of the type required.
      b. Responsibilities include:

1) Reviewing formwork and falsework performance and design criteria stated in the Contract Documents.
2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
3) Preparing or supervising the preparation of design calculations verifying compliance of formwork and falsework with requirements of the Contract Documents.
4) Signing and sealing all calculations.
5) Certifying that:
    a) Design of formwork and falsework was performed in accordance with the performance and design criteria stated in the Contract Documents, and
    b) Design conforms to all Laws and Regulations, and to prevailing standards of practice.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Samples:
        a. Plywood form material used for smooth form finish, four inches square minimum.

B. Informational Submittals: Submit the following:
    1. Shop Drawings: When requested by ENGINEER, submit Shop Drawings showing and indicating general construction of individual forms, including:
        a. Jointing.
        b. Special formed joints or reveals.
        c. Location, pattern, and details of form tie placement, removal, and repair procedures.
        d. Location and details for temporary openings.
        e. Void-form layout drawings and details of installation.
        f. Other items that would visually affect the finished concrete.
    2. Design of Temporary Measures: Design of formwork and falsework is CONTRACTOR's responsibility.

    3. Product Data: Manufacturer's data for proprietary materials, including form coatings, manufactured form systems, ties and accessories.
    4. Manufacturer's Instructions: Installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage:
    1. Upon delivery to the Site, place materials in an area protected from the weather.
    2. Store materials in accordance with the manufacturer's recommendations.

3. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with a protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.

B. Handle materials in accordance with the manufacturers' recommendations. Do not damage materials during handling.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Design Criteria:
1. Design, erect, support, brace and maintain forming in accordance with ACI 347 so that forming safely supports vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by forming system or in-place construction that has attained adequate strength for the purpose. Construct forming so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
2. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on forming, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
3. Provide shores and struts with positive means of adjustment capable of taking up forming settlement during concrete placing operations, using wedges or jacks, or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.
4. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long-span members without intermediate supports, provide camber in forming as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.
5. Design and construct forming to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.
6. Provide forming sufficiently tight to prevent leakage of cement paste during concrete placing. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.
7. Omit side forms of footings and place concrete directly against excavation only when requested by CONTRACTOR in writing and accepted by ENGINEER in writing. When omission of forms is accepted, provide additional concrete required beyond minimum design profiles and dimensions of footings as shown or indicated on the Drawings. No additional compensation will be paid to the CONTRACTOR for additional concrete required.

2.02 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
   1. Unless otherwise shown or indicated in the Contract Documents, construct forming for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to ENGINEER, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by forming. Provide in largest practical sizes to minimize the number of joints and to conform to the joint system shown or specified in the Contract Documents. Provide form material with sufficient thickness to withstand the pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have a standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C. Cylindrical Columns and Supports:
   1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
      a. Provide manufacturer's standard plastic-lined-interior units.
   2. Fiberglass or steel forms may be used for cylindrical columns if accepted by ENGINEER in writing.

D. Form Ties:
   1. Provide factory-fabricated metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal.
   2. Unless otherwise shown or indicated in the Contract Documents, provide ties so that portion of tie remaining within concrete after removal of exterior parts of tie is at least 1.5 inches from the outer concrete surface. Unless otherwise shown or indicated in the Contract Documents, provide form ties that will leave a hole no larger than one-inch diameter in concrete surface.
   3. Ties shall have waterstops on all exterior, below-grade walls, and walls subject to hydrostatic pressure.
   4. Ties shall leave a uniform, circular hole when forms are removed.
   5. Do not use removable ties unless accepted by ENGINEER. Removable ties are not allowed on exterior below-grade walls or walls subject to hydrostatic pressure. If removable ties are accepted, CONTRACTOR shall submit hole repair details for ENGINEER approval.
   6. Wire ties are not allowed.
   7. Do not use reinforcing bars shown by the Drawings as part of the form tie system unless approved by ENGINEER.

E. Form Coatings:
   1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds. For concrete surfaces that

will be in contact with potable water or water that will be treated to become potable, form coating shall be a mineral oil base coating.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine substrate and conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 FORM CONSTRUCTION

A. Construct forms in accordance with ACI 347; to the exact sizes, shapes, lines, and dimensions shown; as required to obtain accurate alignment, location, and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be in accordance with approved mock-up or sample panel, when specified.

B. Allowable Tolerances:
   1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347, Chapter 3, except as otherwise specified.
   2. Construct formwork to provide completed concrete surfaces complying with the following tolerances:
      a. Vertical alignment:
         1) Lines, surfaces and arises less than 100 feet in height – maximum 1 inch not to exceed a 1/2” in any 10-feet.
         2) Outside corner of exposed corner columns and control joints in concrete exposed to view less than 100 feet in height - 1/2 inch.
         3) Lines, surfaces and arises greater than 100 feet in height - 1/1000 times the height but not more than 6 inches.
      b. Lateral alignment:
         1) Members - 1 inch.
         2) Centerline of openings 12 inches or smaller and edge location of larger openings in slabs - 1/2 inch.
         3) Sawcuts, joints, and weakened plane embedments in slabs - 3/4 inch.
      c. Level alignment:
         1) Elevation of slabs-on-grade – maximum 3/4 inch not to exceed ¼-inch in any 10-feet.

2) Elevation of top surfaces of formed slabs before removal of shores - 3/4 inch.

3) Elevation of formed surfaces before removal of shores - 3/4 inch.

4) Lintels, sills, parapets, horizontal grooves, and other lines exposed to view - 1/2 inch.

d. Cross-sectional dimensions: Overall dimensions of beams, joists, and columns and thickness of walls and slabs.

1) 12 inch dimension or less - plus 3/8 inch to minus 1/4 inch.

2) Greater than 12 inch to 3 foot dimension - plus 1/2 inch to minus 3/8 inch.

3) Greater than 3 foot dimension - plus 1 inch to minus 3/4 inch.

e. Relative alignment:

1) Stairs:

(a) Difference in height between adjacent risers - 1/8 inch.

(b) Difference in width between adjacent treads - 1/4 inch.

(c) Maximum difference in height between risers in a flight of stairs - 3/8 inch.

(d) Maximum difference in width between treads in a flight of stairs - 3/8 inch.

2) Grooves:

(a) Specified width 2 inches or less - 1/8 inch.

(b) Specified width between 2 inches and 12 inches - 1/4 inch.

3) Vertical alignment of outside corner of exposed corner columns and control joint grooves in concrete exposed to view - 1/4 inch in 10 feet not to exceed 3/4 inch.

4) All other conditions - 3/8 inch in 10 feet.

5) Offsets between pieces of formwork facing material:

(a) Class A - Architecturally or prominently exposed surfaces - 1/8 inch gradual or abrupt.

(b) Class B - Surfaces to receive plaster or stucco - 1/4 inch gradual or abrupt.

(c) Class C - Exposed surfaces in generally unfinished spaces - 1/4 inch abrupt, 1/2 inch gradual.

(d) Class D - Concealed surfaces – 1/2 inch gradual or abrupt.

C. Install forming and accessories for facilities in accordance with manufacturer's instructions, Laws and Regulations, and the Contract Documents.

D. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

E. Provide temporary openings where interior area of forming is inaccessible for cleanout, for inspection before concrete placement, and for placing concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

F. Forms for Smooth Finish Concrete:
   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
   4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
   5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

G. Corner Treatment:
   1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown or indicated in the Contract Documents. Chamfer exposed corners.
   2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown or indicated in the Contract Documents, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for architecturally formed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
   3. Reentrant or internal and unexposed corners may be formed either square or chamfered.

I. Joints:
   1. For joint treatment, comply with Section 03 15 00, Concrete Accessories. Locate joints as shown and specified.

J. Openings and Built-In Work:
   1. Provide openings in concrete forming shown or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements.
   2. Accurately place and securely support items to be built into forms.

K. Sealing Forming:
   1. Forming joints shall be tight-fitting or otherwise sealed to prevent loss of cement paste.
   2. Provide forming resting against concrete surfaces with compressible gasket material between the concrete and edge of form, to fill irregularities and create tight seal.

L. Cleaning and Tightening:
   1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after placing concrete, as required to eliminate cement paste leaks.

M. Tie Hole Repair:
   1. Repair tie holes in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.03 FORM COATINGS

A. Coat form contact surfaces with non-staining form-coating compound before installing reinforcing materials. Do not allow excess form coating material to accumulate in forms or come into contact with surfaces that will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with non-staining, rust-preventative form oil, or otherwise protect against rusting. Do not use rust-stained steel forming.

C. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be mineral-oil base coating.

3.04 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into forming anchorage devices and other embedded items, shown, specified, or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements. Use necessary setting drawings, diagrams, instructions, and directions.

B. Edge Forms and Screeds Strips for Slabs:

1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screeds.

3.06 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Before placing concrete, check ties, tie cones, tie waterstops, embedded items, form coatings, forming stability, alignment, and tolerances. Make corrections and adjustments to ensure forming complies with intent of the forming design, proper stability of forming systems, and accurate size and location of concrete members.
   2. During concrete placing, check forming and related supports to ensure that forms are not displaced and that completed Work will be within specified tolerances.
   3. If forms are unsatisfactory in any way, either before or during concrete placing, stop or postpone placing of concrete until defects are corrected as required by CONTRACTOR's or Supplier's professional engineer and accepted by ENGINEER.

3.07 REMOVAL OF FORMS

A. Determination of time between placing concrete and removing forms is CONTRACTOR's responsibility. Requirements specified in this Section are minimum times and requirements intended to ensure that concrete will support its own weight, and do not consider additional effects of the construction. Additional effects of the construction shall be accounted for by CONTRACTOR when determining time for removing forming. Time for removing of forms is subject to ENGINEER's acceptance.

B. Comply with requirements of ACI 301 and ACI 347, except as indicated in the Contract Documents.

   1. Removal of Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges:

   2. Comply with requirements of Table 03 11 00-A of this Section:

TABLE 03 11 00-A, REMOVAL OF FORMS

	Average Daily Ambient Air Temperature (deg F)				**Min. Concrete Compressive Strength for Form Removal**
Component	**Over 70 F**	**60 F to 70 F**	**50 F to 60 F**	**Below 50 F**	
Side of beams and girders	One day	One day	Two days		500 psi
Slab and foundation edges	One day	One day	Two days		500 psi

2. When average daily ambient air temperature is below 50 degrees F, do not remove forms until concrete attains minimum compressive strength indicated in Table 03 11 00-A for form removal, and comply with Paragraph 3.8.C.3.b of this Section.
3. Concrete Strength Requirements for Form Removal:
    a. For other than beams and elevated slabs, do not remove forms until concrete attains minimum concrete compressive strength indicated in Table 03 11 00-A for form removal.
    b. For beams and elevated slabs, do not remove supporting forms or shoring until concrete attains minimum of 90 percent of its specified compressive strength.

D. Alternative Criteria for Removing Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges: CONTRACTOR has the option of submitting an alternative removal of forms table, together with supporting data, for ENGINEER's acceptance. Supporting data shall include representative field data for each different placement ambient temperature condition and minimum of three tests per temperature condition to ensure that accurate correlation between concrete strength and placement temperature is obtained.

E. When high-early strength concrete is used, time for removing the forms will be developed at the Site from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI 301.

F. Continue curing, including bottom surfaces of slabs and beams, after form removal in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.09 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the construction. Do not use split, frayed, delaminated, or otherwise damaged form facing material. Apply form coating compound material to concrete contact surfaces as specified for forming.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Form surfaces are subject to ENGINEER's approval.

END OF SECTION

03 15 00 CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete accessories.

B. Related Sections:
   1. Section 03 11 00, Concrete Forming.
   2. Section 03 60 00, Grouting.
   3. Section 07 92 00, Joint Sealants.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 301, Standard Specifications for Structural Concrete.
   2. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   3. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl- Chloride Waterstop.

1.03 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layout of construction and expansion joint locations. Submit and obtain approval prior to submitting concrete reinforcement Shop Drawings.
      b. For construction and expansion joints that require waterstops, submit layout of locations showing waterstop details. Indicate waterstop type, waterstop joint conditions, and details on how joint conditions will be handled.
      c. Detail for joining PVC to steel waterstops.
      d. Layout of all control joint locations.
   2. Samples:
      a. Submit Sample, at least six inches long each, of each type of waterstop proposed for use.
      b. Submit Sample of foam rubber and cork expansion joint fillers.
      c. Submit Sample of each type of prefabricated PVC waterstop joint.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions: Manufacturer's specifications and installation instructions for all materials required.

1.04 DELIVERY, STORAGE AND HANDLING

A. Transportation and Handling of Products:
   1. Deliver materials to Site to ensure uninterrupted progress of the Work.
   2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight. Comply with manufacturer's storage and protection requirements.
   2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 PRODUCTS

2.01 WATERSTOPS

A. Polyvinyl Chloride (PVC):
   1. Material Requirements:
      a. Waterstops shall be extruded from elastomeric PVC compound containing plasticizers, resins, stabilizers, and other materials necessary to meet requirements of the Contract Documents and requirements of CRD-C572. Do not use reclaimed or scrap material.
      b. Tensile strength of finished waterstop: 1,400 psi, minimum.
      c. Ultimate elongation of finished waterstop: 280 percent, minimum.
      d. Minimum thickness shall be 3/8-inch over entire width of waterstop.
      e. Provide waterstops with minimum of seven ribs equally spaced at each end on each side. First rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
      f. Provide waterstops with hog rings or factory-installed grommets anchored to exterior ribs to facilitate tying waterstop in position.
   2. Split waterstops are not allowed.
   3. Construction Joints: Waterstops shall be flatstrip ribbed type, six-inch minimum width, unless otherwise shown or indicated in the Contract Documents.
   4. Expansion Joints: Waterstops shall be centerbulb ribbed type, nine-inch minimum width, unless otherwise shown or indicated in the Contract Documents. Centerbulb shall have minimum outside diameter of 7/8-inch.
   5. Retrofit Applications: Waterstops shall be T-profile, centerbulb ribbed type with six-inch minimum projection into new concrete and anchored to the existing concrete via stainless steel anchor bolts and an epoxy bed.
   6. Product and Manufacturer: Provide one of the following:
      a. W.R. Meadows, Inc.
      b. DCA Construction Products.
      c. Greenstreak Plastic Products Company.
      d. Paul Murphy Plastics Company.
      e. Vinylex Corporation.
      f. Or equal.

B. Hydrophilic Waterstop Materials:
   1. General Material Properties:
      a. Bentonite-free, and expandable by minimum of 80 percent of dry volume in presence of water to form watertight joint seal without damaging concrete in which material is cast. Provide only where shown or indicated in the Contract Documents.
      b. Material shall be composed of resins and polymers that absorb water and cause an increase in volume in completely reversible and repeatable process. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
      c. Select materials that are recommended by manufacturer for type of liquid to be contained.
   2. Hydrophilic Rubber Waterstop:
      a. Minimum cross sectional dimensions shall be 3/16-inch by 3/4-inch.
      b. Product and Manufacturer: Provide one of the following:
         1) Duroseal Gasket, by BBZ USA, Inc.
         2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
         3) Hydrotite, by Greenstreak Plastic Products Company.
         4) Or equal.
   3. Hydrophilic Sealant:
      a. Hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured sealant shall be elastic indefinitely.
      b. Product and Manufacturer: Provide one of the following:
         1) Duroseal Paste, by BBZ USA, Inc.
         2) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
         3) Hydrotite, by Greenstreak Plastic Products Company.
         4) SikaSwell S, by Sika Corporation.
         5) Or equal.
   4. Hydrophilic Injection Resin:
      a. Hydrophilic injection resin shall be acrylate-ester based. Viscosity shall be less than 50 centipoises (cps). Resin shall be water soluble in its uncured state, solvent-free, and non-water reactive. In cured state, resin shall form solid, hydrophilic, flexible material resistant to permanent water pressure, and shall not attack bitumen, joint sealants, and concrete.
      b. Product and Manufacturer: Provide one of the following:
         1) Duroseal Inject 1K/2K, by BBZ USA, Inc.
         2) Sika Injection 29, by Sika Corporation.
         3) Or equal.

2.02 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

2.03 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following for the types of joints specified:
   1. Rugasol-S, by Sika Corporation for horizontal joints only.
   2. Concrete Surface Retarder-Formula S, by Euclid Chemical Company, for horizontal joints only.
   3. Concrete Surface Retarder-Formula F, by Euclid Chemical Company, for vertical joints only.
   4. TK-6100 Concrete Form Surface Retarder, by TK Products.
   5. Or equal.

2.04 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sikadur 32 Hi-Mod LPL, by Sika Corporation.
   2. Eucopoxy LPL, by the Euclid Chemical Company.
   3. Resi-Bond J-58, by Dayton Superior.
   4. Or equal.

2.05 EPOXY-CEMENT BONDING AGENT

A. Provide three component epoxy resin-cement blended formulated as bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
   2. Duralprep A.C., as manufactured by the Euclid Chemical Company.
   3. Emaco P24, as manufactured by MBT/ChemRex.
   4. Or equal.

2.06 JOINT SEALANT AND ACCESSORIES

A. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.07 CONCRETE BOND BREAKERS

A. Provide asphalt-saturated rag felt building paper, not less in weight than commercially known as 15 pound felt building paper, which weighs 15 pounds per 100 square feet.

B. Chemical Bond Breaker:
   1. Provide medium solids resin solution chemical concrete bond breaker complying with ASTM C309, Type I, Class B.

2.08 NEOPRENE BEARING PADS

A. Product and Manufacturer: Provide one of the following:

1. 65 Durometer, Sheet Neoprene No. 1200, as manufactured by Williams Products Company.
2. Or equal.

2.09 RUBBER BONDING AGENT

A. Product and Manufacturer: Provide one of the following:
   1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
   2. Or equal.

PART 3 EXECUTION

3.01 INSPECTION

A. CONTRACTOR and installing Subcontractor, if any, shall examine substrate and conditions under which the Work is to be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 CONSTRUCTION JOINTS

A. Comply with requirements of ACI 301 and the Contract Documents.

B. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by ENGINEER. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
   1. In foundation mats, locate joints at spacing of approximately 40 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings. Element span shall be considered distance between piles or, as determined by ENGINEER, distance between bearing elements, such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
   2. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
   3. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301, unless otherwise shown or indicated on the Drawings.
   4. In slabs on grade, locate joints at spacing of approximately 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

C. Horizontal Joints:
   1. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately

subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.

2. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and all bond-reducing materials just prior to concrete placement.
3. Provide over contact surface of concrete a six-inch layer of Construction Joint Grout as specified in Section 03 60 00, Grouting. Place fresh concrete before grout has attained its initial set. Placement of grout may be omitted if concrete mix has slump increased to at least six inches by addition of high range water reducer.

D. Vertical Joints:
1. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. After roughener is dry, concrete may be placed.
2. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Forms covering member surfaces shall remain in place as required under Section 03 11 00, Concrete Forming. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface.

3.03 EXPANSION JOINTS

A. Comply with requirements of ACI 301 and this Section.

B. Locate and install expansion joints as shown and indicated in the Contract Documents. Install joint filler in accordance with manufacturer's instructions. Install sealants as specified in this Section.

3.04 CONTROL JOINTS

A. Provide control joints in non-water bearing slabs on grade as shown or indicated on the Drawings. Where control joints are not shown or indicated on the Drawings, space control joints at 24 to 36 times thickness of slab in both directions. Locate control joints only at places approved by ENGINEER.

B. A groove, with depth of at least 25 percent of the member thickness, shall be tooled, formed, or saw-cut in concrete. Groove shall be filled with joint sealant material in accordance with Section 07 92 00, Joint Sealants.

C. Where control joint is formed by sawcutting, make sawcut in presence of ENGINEER immediately after concrete has set sufficiently to support the saw and be cut without damage to concrete. Keep concrete continually moist during cutting. Joints shall be approximately 1/8-inch wide.

D. Control joints may be formed with tool or by inserting joint forming strip. After concrete has achieved design strength, remove upper portion of joint forming strip and fill void with sealant.

3.05 ISOLATION JOINTS

A. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doweled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.

3.06 WATERSTOPS

A. General:
   1. Comply with ACI 301 and this Section. Make joints in accordance with manufacturer's instructions.
   2. Provide PVC waterstops, except where otherwise shown or indicated on the Drawings.
   3. Provide waterstops in all joints where concrete construction is below grade or intended to retain liquid. Install waterstop to the higher of: at least 12 inches above grade, or 12 inches above overflow liquid level in tanks.
   4. Waterstops shall be fully continuous for extent of joint and with waterstops in intersecting joints. Maintain waterstop continuity at transitions between waterstops in joints at different levels and orientations.
   5. In vertical joints in walls that are free at the top, waterstops shall extend no closer than six inches from top of wall.
   6. In placing concrete around horizontal waterstops, with waterstop flat face in horizontal plane, work the concrete under waterstops by hand to avoid forming air and rock pockets.

B. Polyvinyl Chloride Waterstop:
   1. Waterstops shall be positively held from displacement during concrete placing. Tie waterstops to reinforcement or other rigid supports at maximum spacing of 18 inches so that waterstop is securely and rigidly supported in proper position during concrete placing. Continuously inspect waterstops during concrete placing to ensure proper positioning.
   2. Perform splicing in waterstops by heat sealing adjacent waterstop sections in accordance with manufacturer's printed recommendations. The following is required:
      a. Material shall not be damaged by heat sealing.
      b. Splices shall have tensile strength of not less than 60 percent of unspliced material's tensile strength.
      c. Maintain the continuity of waterstop ribs and of its tubular center axis.

3. Only butt-type joints of ends of two identical waterstop sections shall be made while material is in forms.
4. Prefabricated PVC Waterstop Joint:
    a. Joints with waterstops involving more than two ends to be jointed together, and joints that involve an angle cut, alignment change, or joining of two dissimilar waterstop sections, shall be prefabricated by CONTRACTOR or manufacturer prior to placing in the forms.
    b. Prefabricated joints shall have minimum of 2.0 feet of waterstop material beyond joint in each direction.
    c. Install prefabricated joint assembly in the forms and butt-weld each two-foot end to a straight-run portion of waterstop in place in the forms.
5. Where centerbulb waterstop intersects and is jointed with non-centerbulb waterstop, seal end of centerbulb using additional PVC material as required.
6. Symmetrical halves of waterstops shall be equally divided between concrete placements at joints and centered within joint width, unless shown or indicated otherwise in the Contract Documents. Place centerbulb waterstops in expansion joints so that centerbulb is centered on joint filler material.
7. When waterstop is installed in the forms or embedded in first concrete placement and waterstop remains exposed to atmosphere for more than four days, implement suitable precautions to shade and protect exposed waterstop from direct rays of sun during entire exposure, until exposed portion of waterstop is embedded in concrete.
8. Protect waterstop placed in joints intended for future concrete placement from direct rays of the sun by temporary means until permanent cover is installed, so that waterstop is not exposed to direct rays of the sun for more than four days total.

C. Hypalon Waterstop:
1. Provide hypalon waterstop where shown or indicated on the Drawings.
2. Install in accordance with manufacturer's recommendations.

D. Hydrophilic Rubber Waterstop and Sealant:
1. Where a hydrophilic rubber waterstop or sealant is required in accordance with the Contract Documents, or where approved by ENGINEER, install waterstop or sealant in accordance with manufacturer's instructions and recommendations; except, as modified in the Contract Documents.
2. When requested by ENGINEER, provide manufacturer's technical assistance at the Site.
3. Locate waterstop or sealant as near as possible to center of joint. Waterstop or sealant shall be continuous around entire joint. Minimum distance from edge of waterstop to face of the member shall be three inches.
4. Where hydrophilic rubber waterstop is used in combination with PVC waterstop, hydrophilic rubber waterstop shall overlap PVC waterstop for minimum of six inches. Fill contact surface between hydrophilic rubber waterstop and PVC waterstop with hydrophilic sealant.
5. Where wet curing methods are used, apply hydrophilic rubber waterstop and sealant after curing water is removed and just prior to closing up of the forms

for concrete placement. Protect hydrophilic rubber waterstop and sealant from direct rays of sun and from becoming wet prior to concrete placement. If material becomes wet and expands, allow material to dry until material has returned to original cross sectional dimensions before placing concrete.

6. Install hydrophilic rubber waterstop in bed of hydrophilic sealant, before skinning and curing begins, so that irregularities in concrete surface are completely filled and waterstop is bonded to sealant. After sealant has cured, install concrete nails, with washers of a diameter equal to waterstop width, to secure waterstop to concrete at maximum spacing of 1.5 feet.
7. Prior to installing hydrophilic sealant, wire brush or sandblast the concrete surface to remove laitance and other materials that may interfere with bonding. Metal and PVC surfaces to receive sealant shall be cleaned of paint and any material that may interfere with bond. When sealant alone is shown or indicated in the Contract Documents, place sealant placed in built-up bead which has a triangular cross section with each side of triangle at least 3/4-inch long, unless otherwise indicated in the Contract Documents. Do not place concrete until sealant has cured as recommended by sealant manufacturer.

3.07 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days, and for bonding to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days, and for bonding to existing concrete.
   2. For locations where bonding agent is required and concrete cannot be placed within open time period of epoxy bonding agent.
   3. Bonding of horizontal construction joints where joints are required in accordance with the Drawings or approved by ENGINEER for foundation mats that are five feet thick or greater.

C. Use cement-water slurry as bonding agent for toppings and concrete fill to new concrete. Cement water slurry shall be worked into surface with stiff bristle broom and place the concrete before cement-water slurry dries.

D. Handle and store bonding agent in accordance with manufacturer's printed instructions and safety precautions.

E. Mix bonding agent in accordance with manufacturer's instructions.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while bonding agent is still tacky (within its open time), without removing in-place bonding agent coat, and as directed by manufacturer.

3.08 BEARING PAD INSTALLATION

A. Neoprene Bearing Pad: Install with water insensitive adhesive in accordance with manufacturer's instructions.

END OF SECTION

03 20 00 CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete reinforcing.
2. Extent of concrete reinforcing is shown and indicated in the Contract Documents.
3. Work includes fabrication and placement of reinforcing including bars, ties, and supports, and welded wire fabric for concrete, encasements, and fireproofing.

B. Related Sections:
1. Section 03 15 00, Concrete Accessories.
2. Section 04 05 05, Unit Masonry Construction.
3. Section 05 05 33, Anchor Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:
1. ACI 315, Details and Detailing of Concrete Reinforcement.
2. ACI 318, Building Code Requirements for Structural Concrete.
3. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
4. ANSI/AWS D1.4, Structural Welding Code - Reinforcing Steel.
5. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
6. ASTM A185, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
7. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM A706, Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
9. ASTM A767, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
10. ASTM A775, Specification for Epoxy-Coated Steel Reinforcing Bars.
11. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
12. Concrete Reinforcing Steel Institute (CRSI), CRSI 1MSP, Manual of Standard Practice.
13. ICC Evaluation Service (ES) AC 308, Acceptance Criteria for Post-Installed Anchors in Concrete Elements.

1.03 QUALITY ASSURANCE

A. Qualifications:
1. Testing Laboratory: Shall meet requirements of ASTM E329 and shall have experience in the testing welded splices of reinforcing steel and

tension testing of reinforcing bars set in adhesive in hardened concrete.

2. Installer of Adhesive Dowels: Shall be experienced and certified by manufacturer of adhesive as possessing necessary training for installing manufacturer's products. Distributors or manufacturer's representatives shall not provide product training unless qualified as certified trainers by anchor manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
    a. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI 315, Parts A and B.
    b. For walls, show elevations at minimum scale of 1/4-inch to one foot.
        1) Elevations shall show all openings and reference details that identify additional reinforcing required around each opening.
        2) Elevations shall denote each wall intersection and reference a detail that identifies additional reinforcing required at wall intersection. As an alternate to providing separate details for each wall intersection, provide overall plan detailing only the additional wall intersection reinforcing for each wall intersection.
    c. For slabs and mats, show top and bottom reinforcing on separate plan views.
        1) Plans shall show all openings and shall reference details that identify additional reinforcing around each opening.
    d. Show bar schedules, stirrup spacing, diagrams of bent bars, location of bar splices, length of lap splices, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing unless otherwise noted.
    e. Provide plans and elevations detailing location, spacing, and lengths of masonry wall dowels, where masonry is required. Coordinate location of dowels with masonry openings and with standard modular spacing. Submit masonry wall dowels with reinforcing submittal for element into which masonry dowel will be embedded. Coordinate with Section 04 05 05, Unit Masonry Construction.
    f. Splices shall be kept to a minimum. Avoid, when possible, splices in regions of maximum tensile stresses.
    g. Drawings detailing location of all construction and expansion joints, as required under Section 03 15 00, Concrete Accessories, shall be submitted and approved before Shop Drawings for reinforcing are submitted.
    h. Drawings detailing location, spacing, edge distance, and embedment depth of adhesive dowels. Adhesive system shall be submitted and approved before Shop Drawings with adhesive dowels are submitted.
2. Product Data:
    a. Manufacturer's product data for adhesive, if not submitted under other Sections.

b. Adhesive manufacturer's test data and ICC ES report to verify specified capacity of adhesive dowels.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Steel manufacturer's certificates of mill analysis, tensile, and bend tests for reinforcing steel.
      b. Certification of welders and weld procedures for splices.
      c. Adhesive manufacturer's certification verifying that installer is qualified and using proper installation procedures.
   2. Manufacturer's Instructions:
      a. Installation instructions for adhesive systems.
   3. Field Quality Control Submittals:
      a. Reports of all field quality control testing, where applicable.
      b. Results of required inspection of welded splices of reinforcing bars.
      c. Results of required tensile testing of adhesive dowels. Include size and location of bars tested.
   4. Special Procedure Submittals; Description of reinforcing weld locations and weld procedures.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.

B. Store concrete reinforcing products to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars: Shall be deformed in accordance with ASTM A615, and as follows:
   1. Provide Grade 60 for all bars, unless indicated otherwise.

B. Mechanical Couplers: Reinforcement bars may be spliced with mechanical connection. Connection shall be full mechanical connection that shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of bar in accordance with ACI 318 and ACI 350. Where splices at the face of wall are shown or approved by ENGINEER, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork.

C. Steel Wire: Shall be in accordance with ASTM A82.

D. Column Spirals: Hot-rolled rods for spirals, conforming to ASTM A615.

E. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place.
   1. Use wire bar type supports complying with CRSI 1 MSP recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, four inches square in plan, with embedded tie wire as specified by CRSI 1 MSP. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.
   3. For concrete surfaces where legs of supports are in contact with forms, provide supports complying with CRSI 1 MSP as follows:
      a. At formed surfaces in contact with soil, weather, or liquid, or located above liquid, supports shall be CRSI Class 1 for maximum protection. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.
      b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
      c. At formed surfaces with an architectural finish, use stainless steel protected legs (Type B).
   4. Over waterproof membranes, use precast concrete chairs.

F. Adhesive Dowels:
   1. Dowels:
      a. Dowel reinforcing bars shall be deformed in accordance with ASTM A615, Grade 60.
   2. Adhesive:
      a. Requirements for adhesive are specified under requirements for concrete adhesive anchors in Section 05 05 33, Anchor Systems.

2.02 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI 1 MSP. In case of fabricating errors, do not re-bend or straighten reinforcing in manner that injures or weakens material.

B. Unacceptable Materials: Reinforcing with one or more of the following defects is not allowed:
   1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
   2. Bends or kinks not shown on approved Shop Drawings.
   3. Bars that do not meet or exceed their ASTM specification requirements when hand-wire-brushed, with respect to cross section, nominal weight, or average height of deformations.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the substrate and conditions under which concrete reinforcing is to be placed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with applicable recommendations of Laws and Regulations, applicable standards, and CRSI 1 MSP for details and methods of reinforcing placement and supports.

B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
   1. Place reinforcing to obtain minimum concrete coverages specified in ACI 318, AC I 350, and the Contract Documents. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Prior to placing concrete, using surveyor's level or string line, demonstrate to ENGINEER that specified cover of reinforcing has been attained.
   3. Do not secure reinforcing steel to forms with wire, nails, or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement, and ACI 350, Chapter 7 - Details of Reinforcement, except as specified in this Section:
   1. Concrete surfaces in contact with liquid shall have minimum of two inches of concrete over reinforcing steel.

E. Provide sufficient number of supports of strength required to carry reinforcing. Do not place reinforcing bars more than two inches beyond last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Lap Splices:
   1. Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars as shown on the Drawings.

G. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams

of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

H. Mechanical Couplers:
   1. Mechanical butt splices shall be in accordance with recommendations of mechanical splicing device manufacturer. Butt splices shall develop 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Bars shall be flame-dried before butt splicing. Provide adequate jigs and clamps or other devices to support, align, and hold longitudinal centerline of bars being butt spliced in straight line.

I. Adhesive Dowels:
   1. Comply with manufacturer's written installation instructions and requirements of this Section.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter and to specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances indicated in ANSI B212.15. Core-drilled holes shall not be permitted.
   3. Before setting adhesive dowel, hole shall be made free of dust and debris by method recommended by adhesive system manufacturer. Brush the hole with adhesive system manufacturer-approved brush and blow hole clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
   4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
   5. Prior to injecting adhesive into the drilled hole, dispense to an appropriate location for waste an initial amount of adhesive from the mixing nozzle until adhesive is a uniform color, indicating that product is properly mixed.
   6. Inject adhesive into hole through injection system-mixing nozzle and extension tubes (as required) placed to bottom of hole. Withdraw nozzle's discharge end as adhesive is placed while keeping nozzle immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placing.
   7. Twist dowel during insertion into partially-filled hole to ensure full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
   8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining or adjacent Work that could impose or impart load on the dowels. Do not begin adjoining or adjacent Work until dowels are successfully tested or when approved by ENGINEER.
   9. Limitations:
      a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with requirements of adhesive systems manufacturer during installation and adhesive system curing.

b. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by adhesive system manufacturer. Cost of corrective measures, including but not limited to redesign of dowels due to decreased capacities, shall be paid by CONTRACTOR.

3.03 FIELD QUALITY CONTROL

A. Site Inspections and Tests:
   1. General:
      a. Do not place concrete until reinforcing is inspected, and permission for placing concrete is granted by ENGINEER. Concrete placed in violation of this provision will be rejected.
      b. Do not close up formwork for walls and other vertical members until reinforcing is inspected, and permission for placing concrete is granted by ENGINEER. Concrete placed in violation of this provision will be rejected.
      c. Correct defective Work by removing and replacing or correcting, as required by ENGINEER.
      d. CONTRACTOR shall pay cost of corrections and subsequent testing required to confirm integrity of post-installed anchors.
      e. Testing laboratory shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
   2. Site Tests:
      a. OWNER will employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
         1) Testing shall comply with ASTM E488.
         2) Test at least ten percent of each type of adhesive dowel. If one or more dowels fail the test, CONTRACTOR shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
         3) Test dowels to 60 percent of specified yield strength. ENGINEER will direct which dowels are to be tested.
         4) Apply test loads with hydraulic ram.
         5) Displacement of dowels shall not exceed D/10, where D is nominal diameter of dowel.
   3. Inspection of Welded Splices: OWNER will employ testing laboratory to perform field quality control testing of welded splices. All welded splices shall be visually inspected. Radiographically test minimum of five percent of butt splice welds. Repair defective welds so that welds are completely sound.

B. Manufacturer's Services:
   1. Provide qualified adhesive manufacturer's representative at the Site during initial installation of adhesive dowel systems to train installing personnel in proper selection and installation procedures. Manufacturer's representative shall observe to verify that installer demonstrates proper installation procedures for adhesive dowels and adhesive material. Each installer shall be certified in writing by manufacturer as qualified to install adhesive anchors.

END OF SECTION

03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cast-in-place concrete.
   2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections, and building into the concrete all items such as sleeves, frames, anchorage devices, inserts, and all other items to be embedded in concrete Work.
      b. Providing openings in concrete to accommodate work under other contracts, and building into concrete items such as sleeves, frames, anchorage devices, inserts, and all other items required to be embedded in concrete under other contracts.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.
   2. Notify other contractors in advance of placing concrete to provide other contractors with sufficient time for installing items included in their contracts that are to be installed in the concrete Work.

C. Classifications of Concrete:
   1. Class “A” concrete shall be steel-reinforced and includes the following:
      a. All concrete, unless otherwise shown or indicated.
   2. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following, unless otherwise shown or indicated:
      a. Concrete fill within structures.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   3. Class “C” concrete shall be steel-reinforced and provided where shown or indicated for slabs that require enhanced durability against wear.

D. Related Sections:
   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 60 00, Grouting.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. AASHTO M 182, Specification for Burlap Cloth Made From Jute or Kenaf and Cotton Materials.
2. AASHTO TP23, Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
3. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
4. ACI 214R, Evaluation of Strength Test Results of Concrete.
5. ACI 301, Specifications for Structural Concrete.
6. ACI 302.1R, Guide for Concrete Floor and Slab Construction.
7. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
8. ACI 305R, Specification for Hot Weather Concreting.
9. ACI 306R, Cold Weather Concreting.
10. ACI 309R, Guide for Consolidation of Concrete.
11. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
12. ACI 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33, Specification for Concrete Aggregates.
15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
17. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
18. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
19. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
20. ASTM C143/C143M, Test Method for Slump of Hydraulic- Cement Concrete.
21. ASTM C150, Specification for Portland Cement.
22. ASTM C157/C157M, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
23. ASTM C171, Specification for Sheet Materials for Curing Concrete.
24. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
25. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
26. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
27. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
28. ASTM C330, Specification for Lightweight Aggregates for Structural Concrete.
29. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
30. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
31. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

32. ASTM C989, Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
33. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
34. ASTM C1077, Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
35. ASTM C1240, Specification for Silica Fume Used in Cementitious Mixtures.
36. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
37. ASTM D3574, Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.
38. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
39. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
40. ASTM E1643, Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
41. ASTM E1745, Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
42. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Concrete Testing Laboratory:
      a. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. Employ different laboratories for design of concrete mixes and field testing.
         1) Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
         2) Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.
         3) Selection of testing laboratory is subject to OWNER's acceptance.
         4) Submit written description of proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities, and equipment, and other information requested by ENGINEER.
   2. Water Reducing Admixture Manufacturer:
      a. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Submit copy of manufacturer's quality assurance handbook to document program existence.
      b. Manufacturer shall maintain a concrete testing laboratory approved by CCRL at NIST.

c. Manufacturer shall be capable of providing services of qualified field service representatives at the Site.

B. Laboratory Trial Batch:
   1. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
   2. For classes of concrete that require air-entrainment, test the trial batch at highest percentage of air allowed for that class of concrete.
   3. Perform the following testing on each trial batch:
      a. Aggregate gradation for fine and coarse aggregates.
      b. Fly ash testing to verify meeting specified properties, unless fly ash Supplier submits certification by an independent testing laboratory.
      c. Slump.
      d. Air content.
      e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
      f. Shrinkage test in accordance with this Section, for Class "A" concrete, Class "AF" concrete and Class "M" concrete.
   4. Submit for each trial batch the following information:
      a. Project identification name and number (if applicable).
      b. Date of test report.
      c. Complete identification of aggregate source of supply.
      d. Tests of aggregates for compliance with the Contract Documents.
      e. Scale weight of each aggregate.
      f. Absorbed water in each aggregate.
      g. Brand, type, and composition of cementitious materials.
      h. Brand, type, and amount of each admixture.
      i. Amounts of water used in trial mixes.
      j. Proportions of each material per cubic yard.
      k. Gross weight and yield per cubic yard of trial mixtures.
      l. Measured slump.
      m. Measured air content.
      n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28 day test, and for each design mix.
      o. Shrinkage test results where required and as specified in this Section. Report results and averages for original length and at zero, seven, 14, 21, and 28 days of drying.

C. Certification of Concrete Mix:
   1. The requirement for trial batch will be waived upon compliance with requirements of this Paragraph. Verify compressive strength of each specified mix by data from series of at least 30 consecutive tests that have been made within previous 12 months. Test is the average strength of all specimens of the same age fabricated from sample taken from a single batch of concrete. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures. Tests shall average above specified strength with no individual test falling more than

500 psi below specified strength and no three consecutive tests averaging below specified strength. Standard deviation for series of tests shall not exceed 640 psi in accordance with ACI 214.

D. Component Supply and Compatibility:
   1. Provide all admixture materials from a single manufacturer.
      a.

E. Designated Finish Sample Areas:
   1. ENGINEER will identify areas of concrete members, to serve as reference examples of acceptable concrete finishes, from first members constructed for each finish.
   2. At each area so designated, complete the finish as specified.
   3. Where specified concrete finish is not obtained, repair the member to provide an acceptable finish. Adjust construction techniques to produce the required finish.
   4. Clearly mark each Sample area with name of specified finish to cause no damage to finish.
   5. Protect Sample areas from damage and maintain access to view Sample areas.

F. Concrete Coordination Conference:
   1. Conduct concrete coordination conference to review detailed requirements of CONTRACTOR's proposed concrete design mixes, to discuss procedures for producing proper concrete construction, and to clarify roles of the parties involved. CONTRACTOR shall organize and schedule the conference, and prepare and distribute to all parties attending conference minutes of the conference.
   2. Conduct concrete coordination conference no later than 14 days after the date the Contract Times commence running. Conference shall be held at mutually agreed upon date and time; conference shall be held at the Site unless otherwise mutually agreed upon. Notify all parties to attend concrete coordination conference not less than five days prior to scheduled date of conference.
   3. All parties involved in the concrete Work shall attend concrete coordination conference including, but not limited to, the following:
      a. CONTRACTOR.
      b. Field testing services representative.
      c. Concrete Subcontractor (if any).
      d. Reinforcing steel Subcontractor (if any) and reinforcing steel Supplier and detailer.
      e. Concrete Supplier.
      f. Admixture manufacturer's representative.
      g. ENGINEER.
      h. Resident Project Representative (if any).

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. List of concrete materials and proportions for the proposed concrete mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
      b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
      c. Ready-mixed Concrete: Submit the following information.
         1) Physical capacity of mixing plant.
         2) Trucking facilities available.
         3) Estimated average amount of the specified concrete that can be produced and delivered to the Site during a normal, eight-hour day, excluding output to other customers.
   2. Product Data:
      a. Manufacturers' specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   3. Samples:
      a. Submit Samples of materials as specified and as requested by ENGINEER. Include with each Sample names of product and Supplier, and description.
      b. Colored Cement Pigment Color Samples: Submit complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Notarized certification of conformance to reference standards used in this Section, when required by ENGINEER.
   2. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site. Each delivery tickets shall contain the information in accordance with ASTM C94 along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.
   3. Field Quality Control Submittals:
      a. Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of associated test. Test report shall include results of all testing required at time of sampling.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transportation, Delivery, and Handling:

1. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
2. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.

B. Storage:
1. For storage, provide bins or platforms with hard, clean surfaces.

PART 2 PRODUCTS

2.01 GENERAL

A. All cementitious materials, admixtures, curing compounds, and other industrial-produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

2.02 CEMENTITIOUS MATERIALS

A. Cement:
1. Portland cement shall be Type II(MH) ASTM C150. Type I or Type II may be used in lieu of Type II(MH) when approved by ENGINEER.
2. Portland cement shall be produced by one facility. Alternate cement sources may be used provided that mix design has been approved and acceptable trial batch verifying performance has been made.
3. Do not use cement that has deteriorated because of improper storage or handling.

B. Fly Ash Mineral Admixture:
1. Mineral admixtures, when used, shall conform to the requirements of ASTM C618 Class F, except as follows:
   a. The loss on ignition shall be a maximum of four percent.
   b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
2. Fly ash shall be considered to be a cementitious material.
3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.
4. If fly ash is to be used in place of cement, no more than 20% percent of the cement may be replaced.

C. Ground Granulated Blast Furnace Slag:
1. Ground granulated blast furnace slag (GGBS) mineral admixture, when used, shall conform to ASTM C989, Grade 120.
2. GGBS is considered a cementitious material.
3. Perform laboratory tests on trial batches to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

D. Silica Fume Mineral Admixture:
   1. Silica fume mineral admixture shall be dry compacted or slurry form and shall conform to ASTM C1240. Silica fume is considered a cementitious material. Application rate shall be seven percent by weight of cement, unless indicated otherwise.

E. For all classes of concrete, when Type II(MH) Cement is used, fly ash or GGBS may be used within the following percentages by weight. When Type II Cement is used, fly ash or GGBS shall be used within the following percentages by weight. When Type I Cement is used, in lieu of Type II(MH) Cement, fly ash or GGBS shall be used such that total tricalcium aluminate content (C3A) of the resulting cementitious material is not greater than eight percent.
   1. When fly ash is used, material shall have minimum of 20 percent and maximum of 25 percent of total weight of cementitious material.
   2. When GGBS is used, material shall have minimum of 40 percent and maximum of 50 percent of total weight of cementitious material.

2.03 AGGREGATES

A. General:
   1. Aggregates shall conform to ASTM C33, Class Designation 4S, and as specified in this Section.
   2. Do not use aggregates containing soluble salts or other substances, such as iron sulfides, pyrite, marcasite, ochre, or other materials, that can cause stains on exposed concrete surfaces.

B. Fine Aggregate:
   1. Provide clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances.
   2. Dune sand, bank run sand, and manufactured sand are unacceptable.

C. Coarse Aggregate:
   1. Provide clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Slag, pit gravel, and bank run gravel are unacceptable.
      c. Lightweight Aggregate: ASTM C330.

2.04 WATER

A. Water used in producing and curing concrete shall be clean and free of injurious quantities of oils, acids, alkalis, organic materials, and other substances that may be deleterious to concrete and steel.

2.05 CONCRETE ADMIXTURES

A. Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion,

and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by ENGINEER.

B. Air Entraining Admixtures: ASTM C260.
   1. Air entraining admixture shall be vinsol resin or vinsol rosin-based.

C. Water-Reducing Admixture: ASTM C494, Type A.
   1. Proportion Class “A”, Class “AF”, Class “AS”, and Class “B” concrete with non-air entraining, normal setting, water-reducing, aqueous solution of modified organic polymer. Admixture shall not contain lignin, nitrates, or chlorides added during manufacturing.

D. High Range Water-Reducing Admixture (HRWR): ASTM C494, Type F/G.
   1. Use high range water-reducing admixture in the concrete classifications so specified or indicated. Use of HRWR admixture is allowed at CONTRACTOR’s option in all other classifications of concrete. When used, HRWR admixture shall be added to concrete in accordance with admixture manufacturer’s published instructions. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.

E. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:
   1. Type B, Retarding.
   2. Type C, Accelerating.
   3. Type D, Water reducing and Retarding.
   4. Type E, Water reducing and Accelerating.
   5. Type F, Water-reducing, high range admixtures.
   6. Type G, Water-reducing, high range, and retarding admixtures.

F. Calcium Chloride: Do not use calcium chloride.

G. Shrinkage Reducing Admixture:
   1. Shrinkage reducing admixture may be used in mix design when necessary to conform to specified shrinkage limitations, provided that specified strength requirements are complied with and there is no reduction in sulfate resistance in the concrete and no increase in concrete permeability.

H. Corrosion-Inhibiting Admixtures:
   1. Corrosion-inhibiting admixture shall be calcium nitrite solution containing minimum of 30 percent calcium nitrite. Admixture shall be added at dosage rate of five gallons per cubic yard of concrete.
   2. Product and Manufacturer: Provide one of the following:
      a. DCI or DCI-S, by Grace Construction Products.
      b. Rheocrete CNI, by Master Builders, Inc.
      c. Eucon CIA, by Euclid Chemical Company.
      d. Or equal.
   3. Adjust quantity of mix water to account for water portion of calcium nitrite solution.

4. Provide retarding admixtures as required, if set time is accelerated.

I. Colored Cement Pigments:
   1. Provide the following, where shown or indicated: Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black compounded for use in concrete.
   2. Product and Manufacturer: Provide one of the following:
      a. Truetone Mortar Colors by Frank D Davis Company, subsidiary of Rockwood Industries, Inc.
      b. Sonobrite by Sonneborn Building Products, division of Rexnord Chemical Products, Inc.
      c. Or equal.
   3. Do not exceed pigment-to-cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
   4. ENGINEER will select colors from manufacturer's full range of standard colors.

2.06 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes in accordance with the table below:

Table 03 30 00-A - CONCRETE DESIGN MIX CRITERIA

Concrete Class	Coarse Aggregate[1]		Minimum Cementitious (lbs/cu yd)	Max. W/CM[4]	Slump[2]	Air (%)	Min. Comp Strength[3] (psi)
	Size A	Size B					
Class "A"	No. 57	No. 8	564	0.42	4" max.	4.5 +/- 1.5	4,500
Class "B"	No. 57 or No. 67		517	0.50	4" max.	4.5 +/- 1.5	3,500
Class "C"	N. 57 or No. 67						2,000

Notes Applicable to Table:
1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03 30 00-A, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.
2. Slumps indicated are prior to addition of high range water reducer (super plasticizer).
3. Mix designs shall be made for all but Class "D", which does not require trial batch, so that the compressive strength achieved for laboratory trial batches will not be less than 125 percent of specified design strength.
4. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.

5. Class “M” Concrete mix design proportions shall be determined by Thermal Control Plan design engineer.

B. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, Site conditions, weather, test results, or other circumstances warrant; at no additional cost to OWNER and as approved by ENGINEER. Before using adjusted concrete mixes, laboratory test data and strength results shall be submitted to and approved by ENGINEER.

C. Admixtures:
   1. Use air-entraining admixture in concrete, unless otherwise shown or indicated. Add air-entraining admixture at admixture manufacturer’s prescribed rate to produce concrete at point of placement having air content within prescribed limits.
   2. Use water-reducing or high-range water-reducing admixtures in all Class “A”, Class “AF” and Class “M” concrete.
   3. Use amounts of admixtures recommended by admixture manufacturer for climatic conditions prevailing at the Site at time of placing. Adjust quantities and types of admixtures as required to maintain quality.

D. If adding water at the Site is desired, withhold water at the batch plant so that specified water-cement (or cementitious material) ratio is not exceeded. Addition of water shall be accordance with ASTM C94. After high-range water-reducing admixture is incorporated into the batch, addition of water is not allowed.

E. Slump Limits with High-Range Water Reducer:
   1. Slump shall not exceed four inches prior to adding high-range water reducer and shall not exceed eight inches, measured at point of placement, after adding high-range water reducer.

F. Shrinkage Limitation:
   1. Concrete shrinkage for specimens cast in laboratory from trial batch with total water of 30.2 gallons per cubic yard or less, as measured at 21-day drying age and at 28-day drying age shall not exceed 0.039 percent and 0.045 percent, respectively. For trial batch with total water of 32.7 gallons per cubic yard or greater respective limits shall not exceed 0.035 percent and 0.040 percent. Limits in between shall be linear interpolated. Use mix design for construction that complies with trial batch shrinkage requirements. Shrinkage limitations apply to Class “A” concrete, Class “AF” concrete and Class “M” concrete.
   2. Trial Batch Does Not Comply with Shrinkage Limitation:
      a. If trial batch results do not comply with shrinkage limitation specified in the Contract Documents, redesign the mix to reduce shrinkage.
      b. After mix has been repeatedly redesigned and ENGINEER is satisfied that all reasonable means to provide concrete mix that complies with shrinkage requirement have been exercised; and mix design still fails to comply with shrinkage limitation in the Contract Documents, ENGINEER reserves the right to accept the higher-shrinkage mix, provided that the quantity of shrinkage reinforcing in structures is increased.

c. "Reasonable means" will be construed as reducing the total water content to a maximum of 27 gallons per cubic yard, having the large aggregate blended so that eight percent to 18 percent of combined aggregate is retained on each sieve, using an alternate aggregate source, and a combination of these means.
d. Basis for shrinkage reinforcing increase will be proportional to amount that shrinkage value is over the specified shrinkage limitation and will be determined by ENGINEER. The cost of providing additional shrinkage reinforcement will be paid by the Owner.

G. Color: Provide colored concrete where shown and indicated. Incorporate pigments into concrete mix according to pigment manufacturer's written instructions. Match color of Sample approved by ENGINEER.

2.07 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents in accordance with Section 03 15 00, Concrete Accessories.

2.08 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Shall be heavy carpets or cotton mats, quilted at four inches on centers, and weighing minimum of 12 ounces per square yard when dry.

C. Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
1. Waterproof paper.
2. Polyethylene film.
3. White burlap polyethylene sheet.

D. Liquid Curing Compound: ASTM C309 Type 1-D (water retention requirements):
1. Provide fugitive dye.
2. Curing compound shall be applied by roller or power sprayer.
3. Product shall be listed in NSF/ANSI 61.

2.09 FINISHING AIDS

A. Evaporation Retardant:
1. Product and Manufacturer: Provide one of the following:
a. Confilm, by Master Builders.
b. Eucobar, by Euclid Chemical Company.
c. SikaFilm, by Sika Corporation.
d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Structural Crack Repair System:

1. Epoxy for Injection: Low-viscosity, high-modulus moisture insensitive type.
2. Products and Manufacturers: Provide one of the following:
    a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
    b. Eucopoxy Injection Resin, by Euclid Chemical Company.
    c. Or equal.
3. Product shall be listed in NSF/ANSI 61.

B. Non-structural Crack Repair System:
1. Hydrophobic Polyurethane Chemical Grout:
    a. Provide hydrophobic polyurethane that forms a flexible gasket.
    b. Products and Manufacturers: Provide one of the following:
        1) SikaFix HH LV, by Sika Chemical Company.
        2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.
        3) Or equal.
    c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
    d. Minimum elongation of 250 percent in accordance with ASTM D3574.
    e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
    f. Product shall be listed in NSF/ANSI 61.
2. Hydrophilic Acrylate-Ester Resin:
    a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume a minimum of 50 percent when in contact with water.
    b. Products and Manufacturers: Provide one of the following:
        1) Duroseal Multigel 850, manufactured by BBZ USA, Inc.
        2) Or equal.
    c. Product shall be listed in NSF/ANSI 61.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be pre-packaged, polymer-modified cementitious repair mortar with the following minimum properties:
1. Compressive Strength at One Day: 2,000 psi (ASTM C109).
2. Compressive Strength at 28 Days: 6,000 psi (ASTM C109).
3. Bond Strength at 28 Days: 1,800 psi (ASTM C882 modified).
4. Material shall be listed in NSF/ANSI 61.

B. Products and Manufacturers: Provide one of the following:
1. Five Star Structural Concrete, by Five Star Products, Inc. Use formulation recommended by manufacturer for the specific application conditions.
2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, by Sika Corporation. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
3. Emaco S88-CA or S66-CR, by Master Builders Inc. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
4. Verticoat, Verticoat Supreme, or Euco SR-VO, by Euclid Chemical Company. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.

5. Or equal.

C. Cement Mortar: Shall consist of mix of one part cement to 1.5 parts sand with sufficient water to form trowelable consistency. Minimum compressive strength at 28 days shall be 4,000 psi. Where required to match the color of adjacent concrete surfaces, blend white portland cement with standard portland cement so that, when dry, patching mortar matches the color of surrounding concrete.

2.12 CHEMICAL HARDENER

A. Provide clear chemical hardener of fluosilicate family.

B. Product and Manufacturer: Provide one of the following:
   1. Lapidolith, by Sonneborn ChemRex Inc.
   2. Hornolith, by A.C. Horn, Inc.
   3. Or equal.

2.13 SHAKE-ON METALLIC HARDENER

A. Provide metallic hardener formulated, processed, and packaged under stringent quality control at metallic hardener manufacturer-owned and -controlled factory. Hardener shall be a mixture of specially-processed and -graded aggregate, selected portland cement, and plasticizing agents.

B. Product and Manufacturer: Provide one of the following:
   1. Euco-Plate H.D., by Euclid Chemical Company.
   2. Masterplate 200, by Master Builders, Inc.
   3. Or equal.

2.14 VAPOR RETARDER

A. Vapor Retarder:
   1. Vapor retarder membrane shall comply with the following.
      a. Water Vapor Transmission Rate, ASTM E96: 0.04 perms or lower.
      b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
      c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
   2. Products and Manufacturers: Provide one of the following:
      a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
      b. Griffolyn 10-mil, by Reef Industries.
      c. Moistop Ultra, by Fortifiber Industries.
      d. Or equal.

B. Accessories:
   1. Provide accessories by same manufacturer as vapor retarder.
   2. Seam Tape:
      a. Tape shall have water vapor transmission rate (ASTM E96) of 0.3 perms or lower.
      b. Products and Manufacturers: Provide one of the following:
         1) Stego Tape by Stego Industries LLC.
         2) Griffolyn Fab Tape by Reef Industries.

3) Moistop Tape by Fortifiber Industries.
4) Or equal.

3. Vapor Proofing Mastic:
   a. Mastic shall have a water vapor transmission rate ASTM E96, 0.3 perms or lower.
4. Pipe Boots:
   a. Construct pipe boots from vapor barrier material, pressure sensitive tape, mastic, or a combination thereof, in accordance with manufacturer's recommendations.

2.15 SOURCE QUALITY CONTROL

A. Concrete materials may require testing, as directed by ENGINEER, at any time during the Work if concrete quality is in question. Provide access to material stockpiles and facilities at all times. Tests shall be done at no expense to OWNER.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the substrate and conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 CONCRETE MIXING

A. General:
   1. Concrete may be produced at batch plants or by the ready-mixed process. Batch plants shall comply with recommendations of ACI 304R and have sufficient capacity to produce concrete of qualities required and in quantities required to comply with the accepted Progress Schedule. All plant facilities are subject to acceptance of ENGINEER.
   2. Mixing:
      a. Mix concrete with a rotating type batch machine, except where hand mixing of very small quantities is approved by ENGINEER.
      b. Remove hardened accumulations of cement and concrete from drum and blades to ensure proper mixing action.
      c. Replace mixer blades upon loss of ten percent of mixer blades' original height.

B. Site Mixing:
   1. When Site mixing of concrete is approved by ENGINEER mix all materials for concrete in a drum-type batch mixer.
      a. For mixers of one cubic yard or smaller capacity, continue mixing at least 1.5 minutes but not more than five minutes after all ingredients are in the mixer, before any part of batch is released.
      b. For mixers of capacity larger than one cubic yard, increase minimum 1.5 minutes of mixing time by 15 seconds for each additional cubic yard or fraction thereof.

2. Do not exceed mixer manufacturer's published rating of the mixer, or mixer nameplate capacity, for total volume of materials used per batch.
3. Equip mixer with automatic controls for proportioning materials and proper, measured quantities.
4. Do not exceed 45 minutes total elapsed time between intermingling of damp aggregates and cement to discharge of completed mix.

C. Ready-Mix Concrete:
1. Comply with ASTM C94 and the Contract Documents.
   a. Plant Equipment and Facilities: Conform to requirements of NRMCA certification.
   b. Mix concrete in revolving-type truck mixers that are in good condition and produce thoroughly-mixed concrete conforming to the Contract Documents.
   c. Do not exceed rated capacity of mixer.
   d. Mix concrete for minimum of two minutes after arrival at the Site, or as recommended by mixer manufacturer.
   e. Do not allow drum to mix while in transit.
   f. Mix at proper speed until concrete is discharged from mixer.
   g. Maintain adequate facilities at the Site for continuous delivery of concrete at required rates.
   h. Provide access to mixing plant for ENGINEER upon request.
2. When silica fume is used in dry compacted form, comply with the following mix requirements and ensure full dispersion:
   a. For all types of mixing equipment, increase mix times by 40 percent over minimum mix time required to achieve mix uniformity defined in ASTM C94.
   b. For truck-mixed and central-mixed concrete, maximum allowable batch size shall be 80 percent of maximum in accordance with ASTM C94.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery to prevent delay of placing concrete after mixing, or holding dry-mixed materials too long in mixer before the adding water and admixtures.

3.03 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Avoid spilling and separation of concrete mixture during transportation.

C. Do not place concrete in which the ingredients have separated.

D. Do not retemper partially set concrete.

E. Use suitable equipment for transporting concrete from mixer to forms.

3.04 PREPARATION FOR CONCRETING

A. Submit to ENGINEER laboratory trial batch test results for proposed mixes at least 15 days prior to start of Work. Do not begin concrete production until associated laboratory trial batch test result submittal has been approved by ENGINEER.

B. Notify ENGINEER a minimum of 24 hours in advance of placing concrete to allow for inspection of form work, joints, waterstops, reinforcement, embedded items, and vapor retarders. The section to be placed shall be fully prepared for concrete placement at the time of notice. Confirm inspection status with ENGINEER a minimum of 4 hours prior to concrete placement. Do not begin placing concrete until Work is in conformance with the Contract Documents.

C. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

D. Reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

E. Do not place concrete until flow of water entering space to be filled with concrete has been properly stopped or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. Do not deposit concrete underwater, and do not allow water to rise on concrete surfaces until concrete has attained its initial set. Do not allow water to flow over concrete surface in manner and or velocity that will injure concrete surface finish. Provide temporary pumping or other dewatering operations for removing water as required.

F. Prepare joint surfaces in accordance with Section 03 15 00, Concrete Accessories.

G. Installation of Vapor Retarder:
   1. Provide vapor retarder under slabs-on-grade and outside walls to receive resilient floor finishes, carpet, ceramic and slate tile, chemical resistant coatings, and where shown or indicated on the Drawings.
   2. Install in accordance with manufacturer's instructions, ASTM E1643, and the following:
      a. Unroll vapor retarder with longest dimension parallel with direction of the pour.
      b. Lap vapor retarder over footings and seal to foundation walls.
      c. Overlap vapor retarder joints by six inches and seal with vapor retarder manufacturer's tape.
      d. Seal penetrations, including pipes, in accordance with vapor retarder manufacturer's instructions.
      e. Penetration of vapor retarder is not allowed except for reinforcing steel and permanent utilities.

f. Repair damaged areas of vapor retarder by providing, for each damaged area, patch of vapor retarder material and overlapping damaged area with the patch by six inches on each side, and securely and continuously taping all four sides of patch to undamaged vapor retarder.

3.05 CONCRETE PLACEMENT

A. General:
1. Place concrete continuously, so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If section cannot be placed continuously, provide construction joints in accordance with Section 03 15 00, Concrete Accessories.
2. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to action that may cause segregation.
3. Screed concrete that is to receive other construction to proper level to avoid excessive skimming or grouting.
4. Do not use concrete that becomes non-plastic and unworkable, or does not conform to required quality limits, or that has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the Site and dispose of it in conformance with Laws and Regulations.
5. Do not place concrete until forms, bracing, reinforcing, and embedded items are each in final position and secure.
6. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
7. Do not place footings, piers or pile caps on frozen soil.
8. Unless otherwise instructed, place concrete only when ENGINEER is present.
9. Allow minimum of three days between adjoining concrete placements.

B. Bonding for Next Concrete Pour:
1. Prepare for bonding of fresh concrete to concrete that has set but is not fully cured, as follows:
   a. Thoroughly wet the surface, but allow no free-standing water.
   b. For horizontal surfaces place a six-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grouting, over the hardened concrete surface.
   c. Place fresh concrete before the grout has attained its initial set.
2. Accomplish bonding of fresh concrete to fully cured, hardened, existing concrete by using a bonding agent as specified in Section 03 15 00, Concrete Accessories.

C. Concrete Conveying:
1. Handle concrete from point of delivery at the Site, transfer to concrete conveying equipment, and transfer to locations of final deposit as rapidly as practical by methods that prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure continuous flow of concrete at delivery end of conveyor. Provide runways for wheeled

concrete conveying equipment from concrete delivery point to locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.

3. Do not use chutes for distributing concrete, unless accepted by ENGINEER.
4. Pumping concrete is allowed, however do not use aluminum pipe for conveying concrete.

D. Placing Concrete into Forms:
   1. Deposit concrete in forms in horizontal layers not deeper than 18 inches each and in manner that avoids inclined construction joints. Where placement consists of several layers, place concrete at such rate that concrete being integrated with fresh concrete while still plastic.
   2. Do not allow concrete to free-fall within the form from height exceeding four feet. Where high-range water reducer is used to extend slump to at least six inches, maximum allowable free-fall of concrete is six feet. Use “elephant trunks” to prevent free-fall and excessive splashing of concrete on forms and reinforcing. Discontinue free-falls in excess of four feet if there is evidence of segregation.
   3. Remove temporary spreaders in forms when concrete placing has reached elevation of such spreaders.
   4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidating concrete in accordance with applicable recommended practices in ACI 309. Vibration of forms and reinforcing is not allowed unless otherwise accepted by ENGINEER.
   5. Where height of concrete placement in walls exceeds 14 feet, provide temporary windows in formwork to facilitate vibration. Properly close temporary windows when height of concrete approaches windows. Determine location, size, and spacing of temporary windows to suit equipment used.
   6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly-spaced locations not farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate the layer of concrete and at least six inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcing and other embedded items without causing segregation of concrete mix.
   7. Do not place concrete in beam and slab forms until concrete previously placed in columns and walls is no longer plastic.
   8. Prevent voids in the concrete. Force concrete under pipes, sleeves, openings, and inserts from one side until visible from the other side.

E. Placing Concrete Slabs:
   1. Deposit and consolidate concrete slabs in continuous operation, within limits of construction joints, until placing of a slab panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcing and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified in this Article for formed concrete structures.
4. Bring slab surfaces to correct elevation and level. Smooth the surface, leaving surface free of humps or hollows. Do not sprinkle water on surface while concrete is plastic. Do not disturb slab surfaces prior to commencing concrete finishing.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, provide evaporation retardant applied in accordance with retardant manufacturer's recommendations, when required by ENGINEER.

F. Quality of Concrete Work:
1. Concrete shall be solid, compact, and smooth, and free of laitance, cracks, and cold joints.
2. Concrete for liquid-retaining structures, and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces with cracks or voids, that are unduly rough, or are defective in any other way. Thin patches or plastering are unacceptable.
4. Leaks through concrete that exhibit flowing water, and cracks, holes, or other defective concrete in areas of potential leakage, shall be repaired and made watertight.
5. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to OWNER.

G. Cold Weather Placing:
1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306 and the Contract Documents.
2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain temperature in area where concrete is being placed between 50 degrees F and 70 degrees F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 55 degrees F and not more than 85 degrees F at point of placement.
4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.

5. Do not use salt or other materials containing antifreeze agents. Do not use chemical accelerators or set-control admixtures unless approved by ENGINEER and tested in mix design proposed for use.

H. Hot Weather Placing:
   1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305 and the Contract Documents.
   2. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.
   3. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided the water equivalent of ice is calculated in total amount of mixing water. If required, reduce the time from addition of mix water to placement, or use set-retarding admixture.
   4. Cover reinforcing materials with water-soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
   5. Wet forms thoroughly before placing concrete.
   6. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
   7. Do not use set-control admixtures unless approved by ENGINEER in mix design.
   8. Obtain ENGINEER's approval of substitute methods and materials proposed for use.

I. Underwater Placing:
   1. Concrete placement in water will be allowed if conditions render it impossible or inadvisable to dewater excavations or liquid-retaining structures before placing concrete, and only when allowed by ENGINEER in writing.
   2. Revise and submit concrete mix design to suit underwater placement, and obtain ENGINEER’s approval before commencing underwater placement of concrete. Deposit concrete by tremie method or other suitable means in continuous placement to prevent forming layers or intrusion of water.

J. Concrete sections with a minimum specified dimension that is greater than 4 feet 6 inches:
   1. Cure and protect concrete in accordance with accepted thermal control plan and as follow:
      a. Minimum curing period shall be 14 days.

b. Unless otherwise permitted, preserve moisture by maintaining forms in place.

2. Strength measurement shall be representative of in-place concrete within 2 inches of concrete surface.
3. Concrete strength shall be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.
4. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at time of protection removal, is less than specified temperature difference limit.

3.06 FINISHING OF FORMED SURFACES

A. Standard Form Finish:
   1. Standard form finish shall be basically smooth and even, but is allowed to have texture imparted by the form material used. Repair defects in accordance with the Contract Documents.
   2. Use standard form finish for the following:
      a. Exterior vertical surfaces from foundation up to one foot below grade.
      b. Vertical surfaces not exposed to view.
      c. Other areas shown or indicated.

B. Smooth Form Finish:
   1. Produce smooth form finish by selecting form materials that will impart smooth, hard, uniform texture. Arrange panels in orderly and symmetrical manner with minimum of seams. Repair and patch defective areas in accordance with the Contract Documents.
   2. Use smooth form finish for the following:
      a. Exterior surfaces exposed to view.
      b. Surfaces to be covered with coating material. Coating material may be applied directly to concrete or may be a covering bonded to concrete such as waterproofing, dampproofing, painting, or other similar system.
      c. Interior vertical surfaces of liquid-containers.
      d. Interior and exterior exposed beams and undersides of slabs.
      e. Surfaces to receive abrasive blasted finish.
      f. Surfaces to receive smooth rubbed or grout cleaned finish.
      g. Other areas shown or indicated.

C. Smooth Rubbed Finish:
   1. Provide smooth rubbed finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
      a. Rubbing of concrete surfaces not later than the day after form removal.
      b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
   2. Use smooth rubbed finish for the following:
      a. Interior exposed walls and other vertical surfaces.

b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
e. Other areas shown or indicated.

D. Grout Cleaned Finish:
1. Provide grout cleaned finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
a. Combine one part portland cement to 1.5 parts fine sand by volume, and mix with water to consistency of thick paint. Blend standard portland cement and white portland cement, in proportions determined by trial patches, so that final color of dry grout will closely match adjacent concrete surfaces.
b. Thoroughly wet concrete surface and apply grout uniformly by brushing or spraying immediately to wetted surfaces. Scrub surface with cork float or stone to coat surface and fill surface holes. Remove excess grout by scraping, followed by rubbing with clean burlap to remove visible grout film. Keep grout damp during setting period by using fog spray on surface for at least 36 hours after final rubbing. Complete each area the same day the area is started, with limits of each area being natural breaks in the finished surface.
2. Use grout cleaned finish for the following:
a. Interior exposed walls and other vertical surfaces.
b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
e. Other areas shown.

E. Abrasive Blasted Finish:
1. Provide abrasive blasted finish where shown or indicated.
2. Where abrasive blasted finish is required, apply finish to smooth formed finish after end of curing period, with defects repaired, to match approved finish provided on mock-up or Sample panel, as applicable.
3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

F. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of

formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown or indicated.

3.07 SLAB FINISHES

A. Float Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Check and level the surface plane to tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to uniform, smooth, granular texture.
   2. Use float finish for the following:
      a. Interior exposed horizontal surfaces of liquid-containing structures, except those to receive grout topping.
      b. Exterior below-grade horizontal surfaces.
      c. Surfaces to receive additional finishes, except as shown or indicated.

B. Trowel Finish:
   1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
   2. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would otherwise project through applied floor covering system.
   3. Use trowel finish for the following:
      a. Interior exposed slabs, unless otherwise shown or indicated.
      b. Slabs that receive one of the following: resilient flooring, carpeting, or ceramic tile.

C. Non-Slip Broom Finish:
   1. Immediately after float finishing, slightly roughen concrete surface by brooming in direction perpendicular to main traffic route. Use fine fiber-bristle broom, unless otherwise directed by ENGINEER. Coordinate required final finish with ENGINEER before applying finish.
   2. Use non-slip broom finish for the following:
      a. Exterior exposed horizontal surfaces subject to lightweight foot traffic.
      b. Interior and exterior concrete steps and ramps.

D. Shake-On Metallic Finish:
   1. For each slab shown or indicated to receive shake-on metallic finish, provide application of shake-on metallic hardener at rate of two pounds per square foot. First shake shall comprise two-thirds of specified quantity of hardener. Provide first application after initial floating operation, unless climatic conditions dictate earlier application. Shake-on metallic hardener shall be

floated in the second application. Surface shall be floated again after second application to properly bond hardener to base concrete slab. Surface shall then be troweled at least twice to smooth, dense finish.

2. Furnish field service upon five days notice by the hardener manufacturer to assist CONTRACTOR in obtaining maximum benefits of product under prevailing conditions at the Site. Hardener manufacturer's representative shall attend concrete coordination conference required in Article 1.03 of this Section.
3. Use shake-on metallic hardener finish with Class "C" concrete for slabs shown or indicated on the Drawings as receiving this finish.
4. Protect slabs against oil and greases. Remove from slab surface dripping, flaking, or loose substances and other bonded foreign particles that might prevent adhesion of finish.
5. Patch and repair other floor imperfections in accordance with hardener manufacturer's recommendations.

E. Scratched Finish:
   1. After providing float finish, roughen concrete surface with rake before concrete's final set. Amplitude of surface shall be minimum of 1/4-inch.
   2. Provide scratched finish for the following:
      a. Horizontal surfaces that will receive grout topping or concrete equipment pad.
      b. Surfaces so indicated on the Drawings or elsewhere in the Contract Documents.

3.08 CONCRETE CURING AND PROTECTION

A. General:
   1. Protect freshly placed concrete from premature drying, excessive cold or hot temperatures, and maintain without drying at relatively constant temperature for period necessary for hydration of cement and proper hardening of concrete.
   2. Start curing after placing and finishing concrete, as soon as free moisture has disappeared from concrete surface. Keep surface continuously moist during entire curing period. Cure for a minimum of 10 days and in accordance with ACI 301 procedures. For concrete sections over 30-inches thick, the curing period shall be for a minimum of 14 days. Avoid rapid drying at end of final curing period.
   3. For curing, use water that is free of impurities that could etch or discolor exposed concrete surfaces.
   4. Confine water for curing to area being cured.

B. Curing Methods: Curing methods are specified below. Curing methods to be used on each type of concrete surface are specified elsewhere in this Article.
   1. Water Curing. Cure by one of the following methods:
      a. Keep concrete surface continuously wet.
      b. Ponding or immersion.
      c. Continuous water-fog spray.

d. Covering concrete surface with curing mats, thoroughly saturating mats with water, and keeping mats continuously wet with sprinklers or porous hoses. Place curing mats to cover concrete surfaces and edges with four-inch horizontal lap over adjacent mats; provide eight-inch lap over adjacent mats at vertical surfaces. If necessary, weigh down curing cover to maintain contact with concrete surface.

2. Form Curing. Cure by one of the following methods:
   a. Forms shall be maintained and loosened during curing period.
   b. Immediately after forms are loosened or removed, continue with the required curing method as applicable, for remainder of curing period.
   c. Where wood forms are kept in place, apply water to keep forms wet.
3. Moisture Retaining Cover Curing. Cure as follows:
   a. Cover concrete surfaces with the required moisture retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches and sealed using waterproof tape or adhesive. Immediately repair holes or tears during curing period using cover material and waterproof tape.
4. Liquid Compound Curing. Cure as follows:
   a. Unless otherwise approved by ENGINEER, provide water curing or form curing. Request to use liquid curing compound will be considered by ENGINEER on case-by-case basis. Construction joints, formed surfaces prior to receiving specified form finish, and concrete to receive surface treatment where surface treatment will be bonded to concrete surface (such as, but not limited to grout fill, hardener, coatings, lining, water repellent, painting, resilient flooring, terrazzo flooring, ceramic tile, quarry tile, chemical resistant coatings, or other applications) shall be water-cured or form-cured.
   b. In liquid-retaining structures, provide water curing or form curing, unless other curing method is approved by ENGINEER. Requests to use liquid curing compound will be considered by ENGINEER on case-by-case basis. Request shall provide valid construction reason or safety reason for using liquid compound curing including reason why other curing methods are not viable.
   c. Apply curing compounds immediately after final finishing or after terminating water curing. Apply curing compound in continuous operation by power spray equipment in accordance with curing compound manufacturer's directions. If areas are subjected to rainfall within three hours after completing curing compound application, area shall be recoated. Maintain coating continuity and repair areas damaged during curing period.
   d. When liquid curing compound is used, apply first coat of liquid curing compound at compound manufacturer's recommended coverage rate, and subsequently apply second coat at identical rate, thus providing twice the curing compound manufacturer's recommended coverage.
   e. At end of curing period, remove liquid curing compound where required.

C. Formed Surfaces: Use the following curing methods:
   1. Walls That Will Retain Liquid or That are Under Ground Surface:

a. If forms are wood, form curing is allowed for entire curing period. If forms are steel, form curing is allowed for maximum of three days after which forms shall be removed so that concrete is free of the forms for remainder of the curing process.
b. Immediately after the forms are loosened or removed, continue with water curing for remainder of curing period.
c. When wall surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.

2. Formed Slab Underside and Beam Surfaces Where Will Retain Liquid:
   a. Form curing is allowed for the full curing period.
   b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
   c. When slab surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed.
3. Vertical Joint Surfaces and Surfaces to Receive Surface Treatment:
   a. Form curing is allowed for entire curing period.
   b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
4. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

D. Unformed Surfaces: Treat with one of the following curing methods:
1. Slabs and Mats That Will Retain Liquid or are Below Ground Surface:
   a. Water curing.
   b. Moisture-retaining cover curing when allowed by ENGINEER.
   c. When slab or mat surface will not receive surface treatment and when allowed by ENGINEER, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.
2. Construction Joint Surfaces and Slab and Mat Surfaces to Receive Surface Treatment.
   a. Water curing.
   b. Moisture-retaining cover curing.
3. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

E. Temperature of Concrete During Curing:
1. When ambient temperature is 40 degrees F or less, continuously maintain concrete temperature between 50 degrees F and 70 degrees F throughout curing period. When necessary, before concrete placing provide for temporary heating, covering, insulation, or housing as required to continuously maintain specified temperatures and moisture conditions throughout concrete curing period. Provide cold weather protection in accordance with ACI 306.
2. When the ambient temperature is 80 degrees F and above, or during other climatic conditions that would cause too-rapid drying of concrete, before starting concrete placing, provide wind breaks and shading as required, and

fog spraying, wet sprinkling, or moisture retaining coverings as required. Continuously protect concrete throughout concrete curing period. Provide hot weather protection in accordance with ACI 305, unless otherwise specified.

3. Maintain concrete temperature as uniformly as possible, and protect from rapid ambient temperature changes. Avoid concrete temperature changes that exceed five degrees F in one hour and 50 degrees F in 24-hour period.

F. Protection:
   1. During curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and damage by rain and flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

3.09 CONCRETE INSTALLATION TOLERANCES

A. Installation Tolerances:
   1. Concrete placement tolerances, unless otherwise specified in the Contract Documents, shall be in accordance with ACI 117.
   2. Notify ENGINEER in writing when concrete placement does not conform with required tolerances, as soon as the condition is known to CONTRACTOR.
   3. When concrete installation does not conform to required tolerances, do not repair or correct by grinding unless specified in the Contract Documents or approved by ENGINEER in writing.
   4. Verification Measurements:
      a. If surfaces where tolerances are in question, obtain measurements to verify conformance with tolerances in manner acceptable to ENGINEER.
      b. If surfaces tolerances are in question, cost of obtaining measurements shall be at no additional cost to the OWNER.
      c. Before obtaining measurements, obtain ENGINEER's acceptance of method proposed for obtaining measurements.
      d. After obtaining measurements, submit measurements to ENGINEER.
   5. Submit with verification measurements submittal proposed method to rectify out-of-tolerance concrete. Do not start repair Work without obtaining ENGINEER's approval.

3.10 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. OWNER will employ testing laboratory to perform field quality control testing for concrete. ENGINEER will direct the testing requirements.
   2. Testing laboratory will make standard compression test cylinders and entrained air tests as specified in this Article, under observation of ENGINEER or Resident Project Representative.
   3. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
   4. CONTRACTOR shall provide all curing and necessary cylinder storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.

B. Field Testing Services:
   1. CONTRACTOR shall employ an independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are to be obtained.
   2. Testing laboratory shall make standard compression test cylinders and entrained air tests as specified in this Article, under direct observation by ENGINEER or Resident Project Representative.
   3. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
   4. Provide all curing and necessary cylinder storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.
   5. Refer to Article 1.03 of this Section for required testing laboratory qualifications.

C. Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during placement of concrete, as follows:
      a. Sampling Fresh Concrete: ASTM C172.
      b. Slump: ASTM C143; one test for each concrete load at point of discharge.
      c. Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
      d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
      e. Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
      f. Compression Test Specimens:
         1) In accordance with ASTM C31; make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
         2) Cast, store, and cure specimens in accordance with ASTM C31.
         3) Test and record the following when cylinders are cast: slump, concrete temperature, air content, and unit weight.
      g. Compressive Strength Tests:
         1) In accordance with ASTM C39; one specimen tested at seven days, and three specimens tested at 28 days.
         2) Adjust mix design if test results are unsatisfactory and resubmit for approval.
         3) Concrete that does not comply with strength requirements will be considered as defective Work.
      h. Water/Cementitious Materials Ratio: Perform test when required by ENGINEER in accordance with AASHTO TP23.
      i. Water/Cementitious Materials Ratio: Perform one test from each sample from which compression test specimens are taken, in accordance with AASHTO TP23.

j. Within 24 hours of completion of test, testing laboratory will submit certified copy of test results to CONTRACTOR and ENGINEER.
k. Submit test results, certified by testing laboratory, to ENGINEER within 24 hours of completion of test.

D. Evaluation of Field Quality Control Tests:
1. Do not use concrete delivered to final point of placement having slump, concrete temperature, total air content or unit weight outside specified values.
2. Water/Cementitious Materials Ratio:
a. When water content testing indicates water/cementitious materials ratio to exceed specified requirements by greater than 0.02, remaining batches required to complete concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as required to bring subsequently-batched concrete within specified water/cementitious materials ratio.
b. Perform additional testing to verify compliance with specified water/cementitious materials ratio.
c. Do not resume concrete production for further concrete placement until CONTRACTOR has identified cause of excess water in the mix and revised batching procedures, or adjusted the mix design (and obtained ENGINEER's associated approval) to bring water/cementitious materials ratio into conformance with the Contract Documents.
3. Compressive Strength:
a. Compressive strength tests for laboratory-cured cylinders will be acceptable if the averages of all sets of three consecutive compressive strength tests results equal or exceed specified 28-day design compressive strength of the associated type or class of concrete, and no individual strength test falls below required compressive strength by more than 500 psi.
b. Questionable Field Conditions During Concrete Placement:
1) Where questionable field conditions exist during concrete placement or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check adequacy of curing and protecting of concrete placed. Specimens shall be molded at the same time and from the same samples as laboratory-cured specimens.
2) Provide improved means and procedures for protecting concrete when 28-day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory cured cylinders.
3) When laboratory-cured cylinder strengths are appreciably higher than minimum required compressive strength, field-cured cylinder strengths need not exceed minimum required compressive strength by greater than 500 psi even though the 85 percent criterion may not be met.
4) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to ensure that

load-bearing capacity of the structure is not jeopardized or impaired. If likelihood of low-strength concrete is confirmed and evaluations indicate load-bearing capacity may have been reduced, perform tests of cores from the concrete in question at CONTRACTOR's expense.

c. If compressive strength tests fail to indicate compliance with minimum requirements of the Contract Documents, concrete represented by such tests will be considered defective.

E. Testing Concrete Structure for Strength:
   1. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42 and the following:
      a. Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by ENGINEER.
      b. Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
      c. Testing laboratory shall submit test results to ENGINEER on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, CONTRACTOR name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
   2. Fill core holes solid with non-shrink grout in accordance with Section 03 60 00, Grouting, and finish to match adjacent concrete surfaces.
   3. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by ENGINEER.

F. Concrete Tolerance Verification Measurements: Refer to Article 3.09 of this Section.

G. Supplier's Services:
   1. Water-Reducing Admixture Manufacturer: Furnish services of qualified concrete technician employed by admixture manufacturer to assist in proportioning concrete for optimum use of admixture. Concrete technician shall advise on proper addition of admixture to concrete and on adjustment of concrete mix proportions to meet changing conditions at the Site.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:
   1. Openings in concrete walls and slabs required for passage of Work are allowed only upon approval of ENGINEER.
   2. Temporary openings made in concrete shall be provided with waterstop in below-ground or liquid-retaining members and structures. Reinforcement going through and around the opening shall be made continuous to provide continuity and shall be approved by the ENGINEER.
   3. Temporary openings that remain in concrete structures shall be filled with the same class of concrete as the adjoining construction, after the Work causing need for temporary opening is complete, unless otherwise shown or directed by ENGINEER. Mix, place, and cure concrete as specified in this Section to blend with in-place construction. Provide miscellaneous concrete filling shown or required to complete the Work.

B. Bases or Pads for Piping, Panels, and Equipment:
   1. Unless specifically shown or indicated otherwise, provide concrete bases or pads for equipment, floor-mounted panels, and floor-mounted supports for piping and similar construction. Provide all concrete pad and base Work not specifically included under other Sections (--1--).
   2. Dimensions and Elevations:
      a. Coordinate and construct bases and pads to dimensions shown or indicated, or as required to comply with equipment, panel, or piping manufacturer's requirements and elevations indicated on the Drawing.
      b. Unless otherwise shown or indicated, place concrete bases for equipment up to one-inch below the equipment manufacturer's base or mounting plate.
      c. Where specific dimensions or elevations are not shown or indicated, bases and pads shall be six inches thick and extend three inches outside dimensions of the equipment, panel, or supports.
   3. Finish: Bases and pads outside of areas to receive non-shrink grout shall have smooth trowel finish, unless special finish such as terrazzo, ceramic tile, quarry tile, or heavy-duty concrete topping is required. In such cases, provide appropriate concrete finish. Surfaces of bases and pads to receive non-shrink grout shall have broom finish.

C. Curbs:
   1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green followed by steel-troweling surfaces to hard, dense finish with corners, intersections, and terminations slightly rounded.
   2. Exterior curbs shall have rubbed finish for vertical surfaces and broomed finish for top surfaces.

D. Steel Pan Stairs:
   1. Provide concrete fill for steel pan stair treads, landings, and associated items. Screed, tamp, and finish concrete surfaces as shown or indicated.
      a. Cast into the concrete fill safety inserts and accessories as shown or indicated.

3.12 REPAIR OF CONCRETE PLACED UNDER THIS CONTRACT

A. Repair of Formed Surfaces:
   1. Repair the following defects in all formed finishes:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
      b. Holes from tie rods and other form tie systems.
      c. Fins, offsets, and other projections that extend more than 1/4-inch beyond designated concrete member surface.
      d. Structural cracks, as defined by ENGINEER.
      e. Non-structural cracks greater than 0.010-inch wide as defined by ENGINEER. In liquid-retaining structures, elevated slabs subject to the elements or washdowns, below-grade members, and cracks that evidence leakage. Where it is not possible to verify whether a crack is leaking, repair the crack.
   2. Repair the following defects in smooth-finish surfaces, in addition to those listed above in this Section:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that extend to more than 1/2-inch in width in any direction, no matter how deep.
      b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch by 12-inch area, or 12 in number in a three-foot by three-foot area.
      c. Fins, offsets, and other projections shall be completely removed and smoothed.
      d. Scratches and gouges in concrete surface.
      e. Texture and color irregularities. In liquid-retaining surfaces, texture and color irregularities need not be repaired when greater than 12 inches below minimum normal operating liquid surface elevation, except where such defects are indicative of reduced durability.
   3. Where smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to finish application, when approved by ENGINEER.

B. Method of Repair of Formed Surfaces:
   1. Immediately after removing forms, repair and patch defective areas with cement mortar or concrete repair mortar as directed by ENGINEER. Make repairs made to liquid-retaining structures and below-grade surfaces with repair mortar only. Repair form tie holes in liquid-retaining or below-grade surfaces with non-shrink grout in accordance with Section 03 60 00, Grouting.
   2. Honeycombs, Rock Pockets, and Holes Left by Tie Rods and Bolts:
      a. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to depth less than one-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to concrete surface.
      b. Before placing cement mortar, thoroughly clean and brush-coat area to be patched with specified bonding agent.

c. When using concrete repair mortar, use of bonding agent is optional; prepare the surface and place mortar in accordance with mortar manufacturer's recommendations.
d. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for interior surfaces of liquid-retaining surfaces up to one foot below typical minimum liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture, and color match before proceeding with patching.
e. Compact mortar in place and strike off slightly higher than the surrounding surface.

3. Structural Cracks: Pressure-grout structural cracks using injectable epoxy installed using pressurized system. Apply in accordance with epoxy manufacturer's directions and recommendations.
4. Non-structural Cracks: Shall be pressure-grouted using hydrophobic or hydrophilic resin. Install in accordance with resin manufacturer's directions and recommendations.
5. Determination of the crack type shall be made by the ENGINEER.
6. Holes Through Concrete:
   a. Using plunger-type gun or other suitable device, fill holes extending through concrete from least-exposed face, using flush stop held at exposed face; completely fill the hole with specified repair material.
   b. At below-grade and liquid-containing members, fill holes with concrete repair mortar and use color-matched cement mortar for outer two inches at exposed-to-view surfaces.
7. Where powerwashing or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to specified tolerances for each surface and finish. Correct low and high areas in accordance with this Section.
2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using template having the required slope. Correct high and low areas in accordance with this Section.
3. Repair finish of unformed surfaces containing defects that adversely affect concrete durability. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
4. Repair structural cracks in all structures and non-structural cracks in liquid-retaining structures. In liquid-retaining structures, where dry face of concrete member can be observed, repair all cracks evidencing any rate of water flow through crack. Where dry face of member cannot be observed, repair all cracks.

D. Methods of Repair of Unformed Surfaces:

1. Correct high areas in unformed surfaces by grinding, after concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
2. Correct low areas in unformed surfaces, during or immediately after completion of surface finishing, by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where repairs are required and concrete has already set, sawcut around perimeter of area to be repaired to depth of 1/2-inch and remove concrete so that minimum thickness of repair is 1/2-inch. Apply specified concrete repair mortar in accordance with repair mortar manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding one-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Minimum thickness of repair shall be 1.5 inches. Dampen concrete surfaces in contact with patching concrete and brush with specified bonding agent. Place patching concrete while bonding agent is tacky. Mix patching concrete of same materials and proportions to provide concrete of same classification as original, adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated, random, non-structural cracks (in members that are not below grade or liquid-retaining), and single holes not greater than one-inch diameter, by dry-pack method. Groove top of cracks, and cut out holes to sound concrete, and clean repair area of dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2.5 parts fine aggregate passing No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for at least 72 hours.
5. Structural cracks shall be pressure-grouted using injectable epoxy. Apply in accordance with epoxy manufacturer's directions and recommendations.
6. Non-structural cracks in below-grade and liquid-retaining structures shall be pressure-grouted using hydrophilic resin. Apply in accordance with resin manufacturer's directions and recommendations.
7. Determination of crack type will be by ENGINEER.
8. Ensure that surface is acceptable for flooring material to be installed in accordance with flooring manufacturer's recommendations.

E. Other Methods of Repair:
   1. Repair methods not specified in this Section may be used when approved by ENGINEER.

END OF SECTION

03 60 00 GROUTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout and perform grouting Work.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before grouting Work.
   2. Notify other contractors in advance of grouting to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before grouting Work.

C. Related Sections:
   1. Section 03 15 00, Concrete Accessories.
   2. Section 03 30 00, Cast-In-Place Concrete.

D. Application and Grout Material:
   1. The following is a listing of grouting applications and the corresponding type of grout material to be provided for the associated application. Unless shown or indicated otherwise in the Contract Documents, provide grout in accordance with the following:

Table 03 60 00-A - GROUT APPLICATIONS AND MATERIAL TYPES

Application	**Required Grout Material Type**
Base plates for storage tanks and other non-motorized equipment, and motorized equipment or machinery less than 50 horsepower	Class I Non-Shrink (unless otherwise recommended by equipment manufacturer)
Motorized equipment or machinery equal to and greater than 50 horsepower, and motorized equipment or machinery equipment less than 50 horsepower subject to severe shock loads or high vibration	Class III Non-Shrink Epoxy (unless otherwise recommended by equipment manufacturer)
Filling blockout spaces for embedded items such as railing posts, guide frames for hydraulic gates, and similar applications	Class II Non-Shrink (Class I where placement time exceeds 15 minutes)
Grout fill or grout toppings less than four inches thick	Grout Fill
Grout fill greater than four inches thick	Class "B" Concrete in accordance with Section 03 30 00, Cast-In-Place Concrete
Applications not listed above, where grout is indicated on the Drawings	Class I Non-Shrink, unless shown or indicated otherwise

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   2. ACI 301, Structural Concrete for Buildings.
   3. ASTM C33/C33M, Specification for Concrete Aggregates.
   4. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   5. ASTM C230/C230M, Specification for Flow Table for Use in Tests of Hydraulic Cement.
   6. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   7. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   8. ASTM C827, Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
   9. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   10. ASTM C939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   11. ASTM C1107/C1107M, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   12. ASTM C1181, Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   13. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Grout Testing Laboratory:
      a. Independent testing laboratory employed for design and testing of grout materials and mixes shall comply with testing laboratory requirements in Section 03 30 00, Cast-in-Place Concrete and other applicable requirements in the Contract Documents.
   2. Manufacturer: Shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
   3. Manufacturer's Field Service Technician: When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

B. Trial Batch:

1. Each grout fill and construction joint grout mix proportion and design shall be verified by laboratory trial batch or field experience methods. Comply with ACI 211.1 and submit to ENGINEER a report with the following data:
    a. Complete identification of aggregate source of supply.
    b. Tests of aggregates for compliance with specified requirements.
    c. Scale weight of each aggregate.
    d. Absorbed water in each aggregate.
    e. Brand, type, and composition of cement.
    f. Brand, type, and amount of each admixture.
    g. Amounts of water used in trial mixes.
    h. Proportions of each material per cubic yard.
    i. Unit weight and yield per cubic yard of trial mixtures.
    j. Measured slump.
    k. Measured air content.
    l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven-day and 28-day test, and for each design mix.
2. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301.
3. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Schedule of Project-specific grout applications, installation locations, and the grout type proposed for each.
        b. List of grout materials and proportions for the proposed mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until submittal is approved by ENGINEER.
        c. Trial Batch Reports: Submit laboratory test reports for grout materials and mix design tests.
    2. Product Data:
        a. Data sheets, certifications, and manufacturer's specifications for all materials proposed for use.

B. Informational Submittals: Submit the following:
    1. Manufacturer’s Instructions:
        a. Special instructions for shipping, storing, protecting, and handling.
        b. Installation instructions for the materials.
    2. Field Quality Control Submittals:
        a. Report field testing results for each required time period. (e.g., seven-day tests, 28-day tests). Submit within 24 hours after completion of associated test. Each test report shall include results of all testing required at time of sampling.

3. Supplier Reports:
    a. Submit written report of results of each visit to Site by Supplier's field service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
4. Qualifications Statements:
    a. Testing laboratory, when not submitted under other Sections.
    b. Manufacturer, when submittal of qualifications is required by ENGINEER.
    c. Manufacturer's field service technician, when submittal of qualifications is required by ENGINEER.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials: Store grout materials in a dry location, protected from weather and protected from moisture.

PART 2 PRODUCTS

2.01 GENERAL

A. All grout materials, admixtures, cementitious materials, and other materials used in grout that contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

2.02 NON-SHRINK GROUT MATERIALS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or container in which the materials are packaged. Specific formulation for each type or class of non-shrink grout specified in this Section shall be that recommended by the grout manufacturer for the particular application.

B. Class I Non-Shrink Grout:
1. Class I non-shrink grouts shall have a minimum 28-day compressive strength of 7,000 psi. Use grout for precision grouting and where water-tightness and non-shrink reliability in both plastic and hardened states is critical, in accordance with Table 03 60 00-A in this Section.
2. Products and Manufacturer: Provide one of the following:
    a. MasterFlow 928, by Master Builders, Inc.
    b. Five Star Grout, by Five Star Products, Inc.
    c. Hi-Flow Grout, by Euclid Chemical Company.
    d. Or equal.
3. Comply with ASTM C1107/C1107M, Grade C and B (as modified below) when tested using amount of water required to achieve the following properties:
    a. Fluid consistency (20 to 30 seconds) shall be in accordance with ASTM C939.

b. At temperatures of 45, 73.4, and 95 degrees F.

4. Length change from placing to time of final set shall not have shrinkage greater than the expansion measured at three or fourteen days. Expansion at three or fourteen days shall not exceed the 28-day expansion.
5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.
6. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

C. Class II Non-Shrink Grout:
1. Class II non-shrink grouts shall have minimum 28-day compressive strength of 7,000 psi. Use grout for general-purpose grouting applications in accordance with Table 03 60 00-A in this Section.
2. Products and Manufacturer: Provide one of the following:
   a. MasterFlow 100, by Master Builders, Inc.
   b. FSP Construction Grout, by Five Star Products, Inc.
   c. NS Grout, by Euclid Chemical Company.
   d. Or equal.
3. Comply with ASTM C1107/C1107M and the following when tested using the quantity of water required to achieve the following properties:
   a. Flowable consistency (140 percent flow in accordance with ASTM C230/C230M, five drops in 30 seconds).
   b. Fluid working time of at least 15 minutes.
   c. Flowable for at least 30 minutes.
4. When tested, grout shall not bleed at maximum allowed water.
5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.

D. Class III Non-Shrink Epoxy Grout:
1. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.
2. Products and Manufacturer: Provide one of the following:
   a. E3G, by Euclid Chemical Company.
   b. Sikadur 42 Grout Pak LE, by Sika Corporation.
   c. HP Epoxy Grout, by Five Star Products, Inc.
   d. Or equal.
3. Epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all pre-measured and prepackaged. Resin component shall not contain non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are unacceptable. Variation of component ratios is not allowed without specific recommendation by manufacturer. Manufacturer's instructions shall be printed on each container in which products are packaged.
4. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   a. Vertical volume change at all times before hardening shall be between zero percent shrinkage and 4.0 percent expansion when measured in accordance with ASTM C827 (modified for epoxy grouts by using an indicator ball with specific gravity between 0.9 and 1.1).

b. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
c. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
d. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
e. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
f. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.
g. Minimum effective bearing area shall be 95 percent.

2.03 GROUT MATERIALS OTHER THAN NON-SHRINK GROUT

A. General: Materials for grouts (other than non-shrink grouts) shall be in accordance with Section 03 30 00, Cast-In-Place Concrete, except as otherwise specified in this Section.

B. Grout Fill:
1. Grout fill shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
a. Minimum Compressive Strength: 4,000 psi at 28 days.
b. Maximum Water-Cement Ratio: 0.45 by weight.
c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
e. Air Content: Seven percent (plus or minus one percent).
f. Minimum Cement Content: 564 pounds per cubic yard.
g. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

C. Construction Joint Grout:
1. Construction joint grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned with similar cementitious characteristics as Class “A” concrete specified in Section 03 30 00, Cast-In-Place Concrete. Mix design shall result in grout that is flowable with high mortar content. Mix requirements are:
a. Minimum Compressive Strength: 4,500 psi at 28 days.
b. Maximum Water-Cement Ratio: 0.42 by weight.
c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
e. Air Content: Seven percent (plus or minus one percent).
f. Minimum Cement Content: 752 pounds per cubic yard.

g. Slump for Construction Joint Grout: Seven inches (plus or minute one inch).

D. Filter Underdrain Blocks Grout:
1. Grout shall comply with Article 2.1 of this Section. Grout shall consist of one part cement to two parts sand with shrinkage-reducing admixture. Class I or Class II non-shrink grout may be used in lieu of filter underdrain blocks grout.

a. Minimum Compressive Strength: 4,000 psi at 28 days.
b. Maximum Water-Cement Ratio: 0.45 by weight.

2.04 CURING MATERIALS

A. Curing materials shall comply with Section 03 30 00, Cast-in-Place Concrete, and shall be as recommended by the manufacturer of prepackaged grouts.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine substrate and conditions under which grouting will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. General:
1. Place grout as shown and indicated, and in accordance with Laws and Regulations and grout manufacturer's instructions. If manufacturer's instructions conflict with the Contract Documents, obtain clarification or interpretation from ENGINEER before proceeding.
2. Consistency of non-shrink grouts shall be as required to completely fill the space to be grouted for the particular application. Do not install grout for dry-packing without approval of ENGINEER. When dry-packing is approved by ENGINEER, dry-pack consistency shall be such that grout has sufficient water to ensure hydration and grout strength development, and remains plastic, moldable, and that does not flow.
3. Grouting shall comply with temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.
4. Cure grout in accordance with grout manufacturer’s instructions for prepackaged grout and Section 03 30 00, Cast-In-Place Concrete, for grout fill.

B. Columns and Beams:
1. After shimming columns and beams to proper elevation, securely tighten anchors. Properly form around base plates allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with non-shrink grout.

C. Equipment Bases:
   1. Install equipment in accordance to manufacturer's recommendations, Laws, and Regulations, and the Contract Documents. After shimming equipment to proper elevation, securely tighten anchors. Properly form around base plates, allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of equipment base and top of concrete base to ensure that voids are completely filled with non-shrink grout.

D. Handrail Posts:
   1. After posts have been properly inserted into holes or sleeves, fill annular space between posts and sleeve with non-shrink grout. Bevel grout at juncture with post so that water will flow away from post.

E. Construction Joints:
   1. Place a six-inch minimum thick layer of construction joint grout over contact surface of concrete at interface of horizontal construction joints in accordance with Section 03 15 00, Concrete Accessories, and Section 03 30 00, Cast-In-Place Concrete.

F. Grout Fill:
   1. All mechanical, electrical, and finish work shall be completed prior to placing grout fill. Base slab shall be provided with a scratched finish in accordance with Section 03 30 00, Cast-In-Place Concrete. Roughen existing slabs shall by abrasive blasting or hydroblasting exposing aggregates to ensure bonding to base slab.
   2. Minimum thickness of grout fill shall be one-inch. Where finished surface of grout fill is to form an intersecting angle of less than 45 degrees with concrete surface against which grout will be placed, form a key in the concrete surface at the intersection point. Key shall be minimum of 3.5 inches wide by 1.5 inches deep.
   3. Thoroughly clean and wet base slab prior to placing grout fill. Do not place grout fill until slab is completely free of standing water. A thin coat of neat Type II cement slurry shall be broomed into surface of slab. Place grout fill while slurry is wet. Grout fill shall be compacted by rolling or tamping, brought to elevation, and floated. In tanks and basins where scraping-type equipment will be installed, grout fill shall be screeded by blades attached to revolving mechanism of equipment in accordance with procedures recommended by equipment manufacturer after grout is brought to elevation.
   4. Grout fill placed on sloping slabs shall be installed uniformly from bottom of slab to top, for full width of placement.
   5. Test grout fill surface with a straight edge to detect high and low spots; immediately correct high and low spots in grout fill. When grout fill has hardened sufficiently, grout fill shall be steel troweled to provide a smooth surface free of bug holes and other imperfections. While an acceptable type of mechanical trowel may be used in this operation, the last pass over the grout fill surface shall be by hand-troweling. During finishing, do not apply

the following to the grout fill surface: water, dry cement, or mixture of dry cement and sand.

6. Cure and protect grout fill in accordance with Section 03 30 00, Cast-In-Place Concrete.

3.03 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. OWNER will employ testing laboratory to perform field quality control testing for grout. ENGINEER will direct the testing requirements.
   2. CONTRACTOR shall provide all curing and necessary cube storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.

B. Field Testing Services:
   1. CONTRACTOR shall employ an independent testing laboratory to perform field quality control testing for grout. ENGINEER will direct where samples are to be obtained.
   2. CONTRACTOR shall provide all curing and necessary cube storage as specified in Section 01 45 28, On-Site Facilities for Testing Laboratory.
   3. Comply with testing laboratory requirements in Section 03 30 00, Cast-In-Place Concrete for required testing laboratory qualifications.

C. Quality Control Testing During Construction:
   1. Grout Fill: Perform sampling and testing for field quality control during grout fill placing as follows:
      a. Sampling Fresh Grout Fill: ASTM C172.
      b. Slump: ASTM C143; one test for each load of grout at point of discharge.
      c. Air Content: ASTM C231; one sample for every two grout loads at point of discharge, and when a change in the grout is observed.
      d. Compression Test Specimens:
         1) In accordance with ASTM C109/C109M; make one set of compression cubes for each 50 cubic yards of grout, or fraction thereof, of each mix design placed each day. Each set shall be four standard cubes, unless otherwise directed by ENGINEER.
   2. Non-shrink Grout: Perform sampling and testing for field quality control during non-shrink grout placing as follows:
      a. Perform compression testing of non-shrink grout in accordance to ASTM C109/C109M at intervals during construction as selected by ENGINEER. Make a set of four specimens for testing compressive strength at a period of time selected by the ENGINEER.
      b. Perform compression tests on epoxy grout and fabricate specimens for epoxy grout testing in accordance with ASTM C579, Method B, at intervals during construction as selected by the ENGINEER. Make a set of four specimens for testing compressive strength at a period of time selected by ENGINEER.

D. Evaluation of Field Quality Control Tests:

1. Do not use grout, delivered to final point of placement, having slump or total air content that does not comply with the Contract Documents.
2. Compressive strength tests for laboratory-cured cubes will be acceptable if averages of all sets of three consecutive compressive strength test results equal or exceed the required 28-day design compressive strength of the associated type of grout.
3. If the compressive strength tests do not comply with the requirements in the Contract Documents, the grout represented by such tests will be considered defective and shall be removed and replaced, or subject to other action required by ENGINEER, at CONTRACTOR's expense.

E. Manufacturer's Services:
1. Manufacturers of proprietary materials shall make available upon 72 hours notification the services of qualified, full time employee, experienced in serving as a field service technician for the products required, to aid in assuring proper use of products under the actual conditions at the Site.

END OF SECTION

05 05 33 ANCHOR SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.
   2. Notify other contractors in advance of installing anchor systems to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before anchor systems Work.

1.02 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   5. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   6. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   9. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   10. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   11. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   12. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   13. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
   14. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   15. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

16. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
17. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
18. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
20. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
21. FS A-A-1923A, Concrete Expansion Anchors.
22. FS A-A-1925A, Shield, Expansion (Nail Anchors).
23. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
24. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
25. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
26. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
27. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
28. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
29. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
30. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer: Shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.

b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.

3. Samples:
   a. Representative Samples of anchor systems proposed for use in the Work. Review will be for type and finish only. Compliance with all other requirements is CONTRACTOR's exclusive responsibility.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
         1) Reports shall demonstrate compliance with ductile steel element definition of ACI 350, Appendix D, Section D.1.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).
   3. Field Quality Control Submittals:
      a. Submit results of field quality control testing and inspections performed by testing laboratory.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:

a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.

b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.

3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria

1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:

a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.02A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.02A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.02A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.

b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.

2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.

3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
   a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
   b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
   c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.
   d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:
   1. Anchor Bolts:
      a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
      b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
   2. Concrete Adhesive Anchors:

a. Use where adhesive anchors are shown or indicated for installation in concrete.
b. Suitable for use where subject to vibration.
c. Suitable for use in exterior locations or locations subject to freezing.
d. Suitable for use in submerged, intermittently submerged, or buried locations.
e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.

3. Grout-filled Concrete Masonry Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in grout-filled concrete masonry units.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
4. Hollow Concrete Masonry Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in hollow concrete unit masonry.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
5. Concrete Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in concrete.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
   d. Do not use in submerged, intermittently submerged, or buried locations.
   e. Suitable for use in overhead applications.
6. Grout-filled Concrete Masonry Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
7. Hollow Concrete Masonry Sleeve Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use in exterior locations or locations subject to freezing.
8. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.

b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
c. Do not use where subject to vibration.
d. Do not use at submerged, intermittently submerged, or buried locations.
e. Do not use in exterior locations or locations subject to freezing.
f. Suitable for use in overhead applications.

9. Concrete Undercut Anchors:
   a. Use where undercut anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Do not use in submerged, intermittently submerged, or buried locations.
   d. Do not use in exterior locations or locations subject to freezing.
   e. Suitable for use in overhead applications.
10. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
11. Drive-In Expansion Anchors:
   a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use in overhead applications.

2.02 MATERIALS

A. Anchor Bolts:
   1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade (--1--), with heavy hex nuts complying with ASTM A563 Grade (--2--), unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
   2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
      a. Stainless steel straight threaded rod shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
   3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.

4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-RE 500-SD Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. SET-XP Epoxy-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Epoxy adhesives shall comply with physical requirements of ASTM C881/C881M, Type IV, Grade 2 and 3, Class A, B, and C, except gel times.
      c. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308.
      d. Adhesives shall have minimum bond strength and minimum design bond strength (bond strength multiplied by strength reduction factor) in accordance with Table 05 05 33-A:

TABLE 05 05 33-A:-ADHESIVE BOND STRENGTH [1,2]

Anchor	**Uncracked Concrete**		**Cracked Concrete**	
Rod Diameter / Dowel Size	**Bond Strength (psi)**	**Design Bond Strength (psi)**	**Bond Strength (psi)**	**Design Bond Strength (psi)**
3/8-inch / #3	2040	1300	1090	700
1/2-inch / #4	1920	1200	920	560
5/8-inch / #5	1830	1150	710	390
3/4-inch / #6	1760	1050	710	460
7/8inch / #7	1670	900	610	340
1-inch / #8	1650	1050	850	460
- / #9	1900	1000	800	400
1.25-inch/ #10	1580	1000	730	400

Table Notes:
1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 110 degrees F and maximum long term concrete temperature of 75 degrees F.

   4. Anchor:
      a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service

Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

b. Stainless steel threaded rod shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.

C. Grout-filled Concrete Masonry Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-HY 150 Max Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Acrylate hybrid adhesives shall comply with the following:
         1) ASTM C579 compressive strength greater than 7,252 psi, or ASTM D695 compressive yield strength greater than or equal to 10,210 psi.
         2) ASTM C307 modulus of elasticity greater than 507,000 psi or ASTM D695 compressive modulus of elasticity greater than 660,800 psi.
      c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES 58.
   4. Anchor:
      a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

D. Hollow Concrete Masonry Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-HY 20 for Masonry Anchoring System, by Hilti Fastening Systems, Inc.
      b. Acrylic-Tie Anchoring Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Hybrid adhesives shall comply with the following:
         1) ASTM D695 compressive strength, greater than 7,410 psi.

2) ASTM D790 modulus of elasticity: 0.33 x 10^6 psi or ASTM D695 compressive modulus of elasticity greater than 0.668 x10^6 psi.

c. Adhesives shall have a current ICC Evaluation Service Report for use in hollow concrete masonry as tested and assessed in accordance with ICC-ES AC58.

4. Anchor:
   a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube:
   a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.
   b. Mesh shall be AISI 304 stainless steel.

E. Concrete Wedge Expansion Anchors:
1. General:
   a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
   a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
   b. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
6. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
7. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

F. Grout-filled Masonry Wedge Expansion Anchors:
1. General:
   a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
2. Product and Manufacturers: Provide one of the following:
   a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
   b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
   c. Or equal.

3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide AISI Type 316 stainless steel anchor, complete with nut and washer, in accordance with ASTM A276 or ASTM A493.
6. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.

G. Hollow Concrete Masonry Sleeve Expansion Anchors:
1. General:
a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.
2. Products and Manufacturers: Provide one of the following:
a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
b. Dynabolt Sleeve Anchors, by ITW Red Head.
c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 304 stainless steel, in accordance with ASTM A276 or ASTM A493.

H. Drop-in Expansion Anchors:
1. General:
a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
c. Or equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

I. Concrete Undercut Anchors:
1. General:
a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer.

Anchors shall be pre-set type or through-set type, as shown on the Drawings.

2. Products and Manufacturers: Provide one of the following:
   a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
   b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
   c. Or equal
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
   a. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

J. Concrete Inserts:
   1. Manufacturers: Provide products of one of the following:
      a. Unistrut Corporation.
      b. Cooper B-Line, Inc.
      c. Anvil International, Inc.
      d. Or equal.
   2. Spot Concrete Inserts:
      a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
   3. Continuous Concrete Inserts:
      a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
   4. Provide inserts with plain finish.

K. Drive-In Expansion Anchors:
   1. General:

a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.

2. Products and Manufacturers: Provide one of the following:
   a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
   b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

L. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

M. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
   a. Pure Nickel Never-Seez, by Bostik.
   b. Nickel-Graf, by Anti-Seize Technology.
   c. Or equal.
2. Provide pure nickel anti-seizing compound.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
3. Protect threads and shank from damage during installation and subsequent construction operations.
4. Unless otherwise shown or approved by ENGINEER anchor bolts shall comply with Table 05 05 33-B:

TABLE 05 05 33-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter	F1554 Grade 36	F1554
	F593 Type 316, Condition A	Grade 55

	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,4] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	1,262	2,420	8.5	12.75	1,660	3,190
5/8	7.5	11.25	2,010	3,860	10.5	15.75	2,640	5,080
3/4	9	13.5	2,974	5,720	13	19.5	3,910	7,520
7/8	10.5	15.75	4,106	7,890	15	22.5	5,400	10,390
1	12	18	5,386	10,360	17	25.5	7,090	13,450
1 1/8	13.5	20.25	6,787	13,052	19	28.5	8,930	16,580
1 1/4	15	22.5	8,617	16,572	21	31.5	11,340	20,040

TABLE 05 05 33-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter (inch)	F1554 Grade 36 F593 Type 316, Condition A				F1554 Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,4] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	947	1,815	8.5	12.75	1,245	2,393
5/8	7.5	11.25	1,508	2,895	10.5	15.75	1,980	3,810
3/4	9	13.5	2,231	4,290	13	19.5	2,933	5,640
7/8	10.5	15.75	3,080	5,918	15	22.5	4,050	7,793
1	12	18	4,040	7,770	17	25.5	5,318	10,088
1 1/8	13.5	20.25	5,090	9,789	19	28.5	8,930	12,435
1.1/4	15	22.5	6,463	12,429	21	31.5	8,505	15,030

Table Notes:

1. Table is based on ACI 318 and ACI 350, Appendix D, f'_c = 4000 psi. Table 05 05 33-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by ENGINEER in accordance with ACI 318 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:

1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
   1. Comply with manufacturer's written installation instructions and the following.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
   3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
   4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
   5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
   6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
   7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
   8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
   9. Limitations:
      a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
      b. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
      c. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
   1. Comply with expansion anchor manufacturer's written installation instructions and the following:
   2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
   3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
   4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
   5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:
   1. Comply with undercut anchor manufacturer's written installation instructions and the following.
   2. Protect threads from damage during anchor installation.
   3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
   4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
   5. Insert the anchor by hand until anchor reaches bottom of hole.
   6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
   7. Verify that the setting mark is visible on the threaded rod above the sleeve.
   8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:
   1. Comply with concrete insert manufacturer's installation instructions.
   2. Inserts shall be flush with slab bottom surface.
   3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
   4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:
   1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.01B of this Section.

2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.03 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.04 FIELD QUALITY CONTROL

A. Site Tests:
   1. OWNER Will employ testing agency to perform field quality tensile testing of post-installed anchors at the Site.
      a. Testing shall comply with ASTM E488.
      b. Test at least ten percent of all types of post-installed anchors. If one or more post-installed anchors fail the test, CONTRACTOR shall pay cost of testing, or at ENGINEER's option CONTRACTOR may arrange for testing paid by CONTRACTOR, for all post-installed anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, ENGINEER may require retesting of all anchors of the same diameter and type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
      c. Test post-installed anchors to 50 percent of ultimate tensile capacity of post-installed anchor. ENGINEER will direct which anchors are to be tested.
      d. Apply test loads with hydraulic ram.
      e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.
   2. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.
   3. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm integrity of post-installed anchors.
   4. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

B. Manufacturer's Services:
   1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

END OF SECTION

05 50 00 MISCELLANEOUS METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish miscellaneous metal fabrications, including surface preparation and shop priming.

B. The extent of miscellaneous metal fabrications Work is shown on the Drawings and includes items fabricated from iron, steel and aluminum shapes, plates, bars, castings and extrusions, which are not a part of the structural steel or other metal systems covered by other Sections of these Specifications.

C. The types of miscellaneous metal items include, but are not limited to the following:
   1. Bollards.
   2. Miscellaneous framing and supports.
   3. Miscellaneous accessories and fasteners.
   4. Seat Angles, supports and brackets.

D. Related Sections:
   1. Section 05 05 33, Anchor Systems.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified:
   1. ASTM A 36, Specification for Carbon Structural Steel.
   2. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   4. ASTM A 276, Stainless and Heat-Resisting Steel Bars and Shapes.
   5. ASTM A 320, Specification for Alloy Steel Bolting Material for Low Temperature Service.
   6. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   7. ASTM B 211, Specification for Aluminum and Aluminum-Alloy Bars, Rods and Wire.
   8. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   9. ANSI A14.3, Safety Requirements for Fixed Ladders.
   10. AWS D1.1, Structural Welding Code.
   11. NAAMM, Metal Finishes Manual.
   12. OSHA.

B. Field Measurements:
   1. Take field measurements where required prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

C. Shop Assembly:
   1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Fabrication and erection details of all assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for location and installation of miscellaneous metal items and anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A 36.

B. Aluminum:
   1. Alloy and Temper: Provide alloy and temper as shown on the Drawings or specified, or as otherwise recommended by the aluminum producer or finisher.
   2. Extruded Shapes and Tubes: ASTM B 241.
   3. Plate and Sheet: ASTM B 209.
   4. Bars, Rods and Wire: ASTM B 211.

C. Stainless Steel Plates, Sheets and Bars: ASTM A 276, Type 316 stainless steel.
   1. Use Type 316 stainless steel unless shown otherwise in the Drawings.

D. Stainless Steel Fasteners and Fittings: ASTM A 320.

E. Surface Preparation and Shop Priming: All steel shall be primed in the shop.

F. Galvanizing: All galvanizing of fabricated steel items shall comply with the requirements of ASTM A 123.

G. Aluminum Finish: Provide an Architectural Class I anodized finish for all aluminum work unless specifically shown or specified to be mill or other finish.

2.02 MISCELLANEOUS METAL ITEMS

A. Bollards: Unless shown otherwise in the Drawings, provide 8-inch diameter, Schedule 40 galvanized steel pipe, 4-feet-0-inches above grade, 4-feet-0-inches below grade. Fill with

concrete and mound top. Bollards shall be primed in the shop. Surface preparation and painting shall conform to the requirements of Section 09 91 00.

B. Miscellaneous Framing and Supports:
   1. Provide miscellaneous metal framing and supports, which are not a part of the structural steel framework and are required to complete the Work.
   2. Fabricate miscellaneous units to the sizes, shapes and profiles shown on the Drawings or, if not shown on the Drawings, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown on the Drawings, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.
   3. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
      a. Except as otherwise shown on the Drawings, space anchors, 24-inches on centers, and provide units the equivalent of 1-1/4 by 1/4 by 8-inch strips.
      b. All material shall be Type 316 stainless steel unless noted otherwise in the Drawings.

C. Fasteners and Fittings: Provide Type 316 stainless steel, for all aluminum fabrications, and zinc coated hardware for all galvanized fabrications, unless otherwise shown on the Drawings or specified.

D. Surface Preparation and Shop Priming: All miscellaneous metal fabrications shall be primed in the shop.

E. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA M32C22 A41, clear, as specified in NAAMM Manual.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set miscellaneous metal fabrications accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry or similar construction.

B. Anchor securely as shown on the Drawings or as required for the intended use, using concealed anchors wherever possible.

C. Fit exposed connections accurately together to form tight hairline joints. Weld steel connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind steel joints smooth and touch up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:
   1. Coat all surfaces of aluminum in contact with dissimilar materials, such as concrete, grout, masonry and steel or other dissimilar metals with the following:
      a. Cast Aluminum: Heavy coat of bituminous paint.
      b. Extruded Aluminum: Two coats of clear lacquer.
   2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

E. E. All welds to be coated shall be grinded smooth according to NACE “Surface Preparation of Welds Prior to Coating”.

END OF SECTION

09 91 00 PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
      a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included in the general contract and other contracts described in this Section.
   2. Extent of painting includes the Work specified below. Painting shown in schedules may not provide CONTRACTOR with complete indication of all painting Work. Refer to Article 2.2 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
      a. Follow the Painting Schedule in Article 3.8.
      b. All new and specifically identified existing surfaces and items except where natural finish of material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note, or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
      c. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown or specified.
      d. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.

B. Coordination:
   1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
   2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
   3. Furnish information to ENGINEER on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.

C. Related Sections:
   1. Section 07 92 00, Joint Sealants.

D. Work Not Included: The following Work is not included as painting Work, or are included under other Sections or in other contracts:
   1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections.
   2. Pre-finished Items:
      a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by CONTRACTOR using manufacturer's recommended compatible field-applied touchup paint.
      b. Items furnished with finishes such as chrome plating or anodizing.
   3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases, duct shafts, and elevator shafts.
   4. Concrete surfaces.
   5. Concrete floors, unless specifically shown as a surface to be painted.
   6. Face brick, glazed structural tile, and prefaced, ground-faced or split-faced concrete unit masonry.
   7. Exterior face of architectural precast concrete.
   8. Collector bearings, shafts and chains, wood flights, wood stop logs, and wood or fiberglass baffles.
   9. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
   10. Operating Parts and Labels:
      a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
      b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
      c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.
   11. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
   12. Existing structures, equipment, and other existing surfaces and items unless otherwise shown or specified.

E. Description of Colors and Finishes:
   1. Color Selection:
      a. ENGINEER reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to OWNER.

2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
    a. Color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1, CFR 1910.144, Recommended Standards for Water Works, and Recommended Standards for Wastewater Facilities. For piping and equipment not covered by the above standards, conform to OWNER's color standards.
    b. For equipment located on roofs and equipment that is exposed-to-view, color will be selected by ENGINEER.

1.2 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:
    1. ANSI A13.1, Scheme for Identification of Piping Systems.
    2. ANSI Z535.1, Safety Color Code.
    3. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
    4. ASTM D2200, Pictoral Surface Preparation Standards for Painting Steel Surfaces.
    5. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
    6. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
    7. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
    8. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
    9. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
    10. GLUMRB, Recommended Standards for Wastewater Facilities.
    11. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.
    12. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
    13. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
    14. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
    15. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

A. Coating terms defined in ASTM D16 apply to this Section.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications:
    1. Engage a single applicator regularly performing installation of painting systems, with documented skill and successful experience in installing types of products required and agrees to employ only tradesmen trained, skilled, and with successful experience in installing types of products specified.

B. Testing Agency Qualifications: Provide independent testing agency with experience and capability to satisfactorily conduct testing specified in accordance with ASTM E329. Testing agency shall be selected by OWNER and paid for by CONTRACTOR.

C. Source Quality Control:
   1. Obtain products from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work to advise on products, mock-ups, installation, and finishing techniques, at completion of the Work to advise ENGINEER on acceptability of completed Work, and during course of Work as requested by ENGINEER.
   2. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
   3. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in painting systems.
   4. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services indicated. Comply with the following:
      a. Lead and Chromate: Lead and chromate content shall not exceed amount allowed by authorities having jurisdiction.
      b. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in areas subject to hydrogen sulfide fume exposure.
      c. Manufacturer shall identify colors that meet requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water that will be treated to become potable.
      d. Comply with paint manufacturers' recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

D. Regulatory Requirements:
   1. Comply with VOC content limits of Ozone Transport Commission (OTC), Model Rule for Architectural and Industrial Maintenance Coatings.

E. Pre-Painting Conference:
   1. Conduct a pre-painting conference at the Site to review specified requirements. Meeting attendees shall include painting applicator and its foreman, paint manufacturer's technical representative, installers of other work in and around painting that must follow painting Work, ENGINEER, and other representatives directly concerned with performance of painting Work.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Copies of manufacturer's technical data sheets, including surface preparation, number of coats, dry film thickness, test performance data including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use
      b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.

c. Copies of CONTRACTOR’s proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.

d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer’s catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to ENGINEER for that system, proof of additional material purchase shall be provided to ENGINEER. Calculated coverage shall be as specified for each component of each painting system specified. This requirement does not take precedence over CONTRACTOR’s responsibility to provide dry film thickness required for each component of each painting system.

e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.

f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.

g. Specification for spray equipment with cross-reference to paint manufacturer’s recommended equipment requirements.

2. Samples:

a. Copies of manufacturer's complete color charts for each coating system.

B. Informational Submittals: Submit the following:

1. Certificates:

a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.

b. CONTRACTOR shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer’s recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.

2. Test Reports:

a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.

b. Adhesion testing plan and procedures.

c. Results of adhesion testing on existing surfaces containing paints or other coatings to be topcoated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods, procedures, and painting system modifications, if necessary, for proceeding with Work.
d. Locations of and test methods for soil sampling before beginning Work and after Substantial Completion.
e. Proposed methods for testing, handling, and disposal of waste generated during Work.
f. Results of alkalinity and moisture content tests performed per ASTM D4262 and ASTM D4263.
g. Results of film thickness, holidays, and imperfections tests.

3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.
5. Special Procedure Submittals:
   a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.
   b. Site-specific health and safety plan.
   c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
   d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.
6. Qualifications:
   a. Applicator.
   b. Testing laboratory

C. Closeout Submittals: Submit the following:
1. Maintenance Manual: Upon completion of the painting Work, furnish ENGINEER five copies of detailed maintenance manual including the following information:
   a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
   b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
   c. Detailed procedures for routine maintenance and cleaning.
   d. Detailed procedures for light repairs such as dents, scratches and staining.
2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to ENGINEER signed by CONTRACTOR and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.6 DELIVERY, STORAGE AND HANDLING

A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
   1. Container contents, including name and generic description of product.
   2. Manufacturer's stock number and date of manufacture.
   3. Manufacturer's name.
   4. Contents by volume, for major pigment and vehicle constituents.
   5. Grams per liter of volatile organic compounds.
   6. Thinning instructions, where recommended.
   7. Application instructions.
   8. Color name and number.

B. Product Storage Requirements:
   1. Store acceptable materials at Site.
   2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
   3. Store products that are not in actual use in tightly covered containers.
   4. Comply with health and fire regulations of authorities having jurisdiction at Site.

C. Product Handling Requirements:
   1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
   2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
   3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

A. Site Facilities:
   1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system applications, are not available at the Site.
   2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance, and temperature-monitoring personnel is CONTRACTOR's responsibility.
   3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent heat sources to exterior so that paint systems and personnel are unaffected by exhaust products.

B. Existing Conditions:
   1. Existing surfaces to receive painting Work shall have their surfaces prepared to meet requirements of painting systems specified. Prior to initiating painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be

sufficient to determine the condition of existing coatings and suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER the adhesion test results.

2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA(filters and dust containment systems.
4. After painting operations have started in a given area, cleaning only with commercial vacuum cleaning equipment with high-efficiency particulate air (HEPA) filters and dust containment systems.

C. Environmental Requirements:
   1. Comply with manufacturer's published requirements.

D. Protection:
   1. Cover or otherwise protect finished Work of other trades and those surfaces not being painted concurrently and not to be painted.
   2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
   3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
   4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until ENGINEER accepts protection techniques proposed by CONTRACTOR.
   5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

A. Products and Manufacturers: Where referenced under painting systems, provide painting systems manufactured by the following:
   1. Tnemec Company, Incorporated (TCI).
   2. The Carboline Company, subsidiary of RPM International Inc (TCC).
   3. Sherwin-Williams Company (SWC).
   4. Or equal.

2.2 PAINTING SYSTEMS

A. New and Existing Concrete Unit Masonry Walls; Moderate Corrosion and Abrasion Resistant, Non-submerged, Interior:
   1. Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
   2. Filler, Surfacer and Patching Compound:

a. Generic Components:
1) Minimum 68 percent volume solids, high-build, three-component, waterborne cementitious acrylic block filler; 75 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 130 Envirofill (TCI); Sanitile 600 TG (TCC); Cement-Plex 875 (SWC): One coat, 10 to 14 dry mils.
3. Intermediate/Finish:
a. Generic Components:
1) Minimum 80 percent volume solids, high-build, chemical-resistant, high-gloss, modified, polyamine or polyamido-amine catalyzed epoxy finish; 180 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 280 Tneme-Glaze (TCI); Carboguard 890 LT (TCC); Cor-Cote HP (SWC):
a) Vertical Surfaces: Two coats, 4.0 to 8.0 dry mils, per coat.

B. New and Existing Concrete Unit Masonry Walls; Non-submerged, Exterior:
1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
2. Filler, Surfacer and Patching Compound:
a. Generic Components:
1) Minimum 68 percent volume solids, high-build, three-component, waterborne cementitious acrylic block filler; 75 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 130 Envirofill (TCI); Sanitile 600 TG (TCC); Cement-Plex 875 (SWC): One coat, 10 to 14 dry mils.
3. Finish:
a. Generic Components:
1) Minimum 49 percent volume solids, flexible, high-build, single-component, modified waterborne acrylate or water-based epoxy, 151 grams per liter VOC, maximum
b. Products and Manufacturers: Provide one of the following:
Series 156 Enviro-Crete; (TCI); Sanitile 555 (TCC); Epo-Plex Multi-Mil Low-Luster (SWC): One coat, 6.0 to 8.0 dry mil
1) Series 156 Enviro-Crete; (TCI); Sanitile 555 (TCC); Epo-Plex Multi-Mil Low-Luster (SWC): One coat, 6.0 to 8.0 dry mil.

C. New Ferrous Metals, Structural Steel, Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal; Non-submerged, Interior:
1. Shop Primer:
a. Generic Components:
1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:

1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.

2. Field Primer and Touch-Up:
   a. Generic Components:
      1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum
   b. Products and Manufacturers: Provide one of the following:
      1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); One coat, 4.0 to 6.0 dry mils.
3. Finish: High-Gloss:
   a. Generic Components:
      1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:
      1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.

D. New and Existing Ferrous Metals, Galvanized Metals and Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged and Intermittently Submerged, including up to 4.0 feet above liquid surface; Certified per ANSI/NSF Standard 61; Moderate VOC Content, Interior:
   1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
   2. Primer/Finish:
      a. Generic Components:
         1) Minimum 100 percent solids, modified polyamine epoxy or flake-filled epoxy; 8 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series 22 Pota-Pox 100 (TCI); Plastite 140 S (TCC); Dura-Plate UHS NSF (SWC): Two coats, 8.0 to 10.0 dry mils, per coat.

E. New and Existing Ferrous Metals, Non-Ferrous Metals, and Galvanized Metals; Low VOC Content, Non-Submerged, Exterior:
   1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
   2. Ferrous Metal Primer:
      a. Generic Components:
         1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy coating; 250 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series V69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
   3. Ferrous Metal Touch-Up:
      a. Generic Components:

1) For Low-temperature Curing Conditions: Minimum 80 percent solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.
2) For Warm-temperature Curing Conditions: Minimum 80 percent volume solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.

b. Products and Manufacturers: Provide one of the following:
1) For Low-temperature Curing Conditions: Series 136, Chembuild FC (TCI); Carboguard 890 LT (TCC); Macropoxy HS Epoxy (SWC): One coat, 10.0 dry mils.
2) For Warm-temperature Curing Conditions: Series 166 Epoxoline HS (TCI); Carboguard 1207 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 6.0 dry mils.

4. Galvanized and Non-Ferrous Primer.
a. Generic Components:
1) Refer to Paragraph 2.2.E.2.a.1), above.
b. Products and Manufacturers: Provide one of the following:
1) Refer to Paragraph 2.2.E.2.b.1), above.

5. Intermediate – Ferrous Metals Only:
a. Generic Components:
1) Refer to Paragraph 2.2.E.3.a.1), above.
2) Refer to Paragraph 2.2.E.3.a.1), above.
b. Products and Manufacturers: Provide one of the following:
1) Refer to Paragraph 2.2.E.3.a.1), above.
2) Refer to Paragraph 2.2.E.3.b.1), above.

6. Finish: Gloss:
a. Generic Components:
1) Minimum 49 percent volume solids, two-component, waterborne acrylic polyurethane or aliphatic acrylic polyurethane coating; 247 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 1080 Endura-Shield WB (TCI); Carbothane 134 VOC (TCC); Centurion WB Urethane (SWC): Two coats, 2.0 to 3.0 dry mils.

F. New and Existing Galvanized Metal, Non-Ferrous Metal, and Fiberglass; Non-submerged, Interior:
1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
2. Primer:
a. Generic Components:
1) Minimum, 39 percent volume solids single-component, self-cross linking acrylic primer-sealer, 140 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 115 Uni-Bond DF (TCI); Galoseal Wash Primer (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.
3. Finish: Satin:
a. Generic Components:

1) Minimum, 41 percent volume solids, single component, self-cross linking acrylic; 208 grams per liter VOC, maximum.

b. Products and Manufacturers: Provide one of the following:

1) Series 116 Uni-Bond (TCI); Carbocrylic 3359 (TCC); DTM Acrylic Coating (SWC): One coat, 2.0 to 4.0 dry mils.

G. New and Existing Aluminum in Contact with Dissimilar Materials:

1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
2. Primer/Finish:
   a. Generic Components:
      1) Minimum 100 percent volume solids, high-build, two-component, polyamido-amine or polyamine epoxy; 49 grams per gallon VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:
      1) Series 165 Epoxoline 100 (TCI); Carboguard 954 HB (TCC); Dura-Plate UHS (SWC): Two coats, 8.0 to 15.0 dry mils, per coat.

H. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior:

1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
2. Primer:
   a. Generic Components:
      1) Minimum 37 percent volume solids single-component, self-cross linking acrylic primer-sealer; 226 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:
      1) Series 115 Uni-Bond DF (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): One coat, 2.0 to 4.0 dry mils.
3. Finish: Satin:
   a. Generic Components:
      1) Minimum 37 percent volume solids, single component, self-cross linking acrylic; 226 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:
      1) Series 116 Uni-Bond (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): One coat, 2.0 to 4.0 dry mils.

I. New and Existing Gypsum Wallboard and Wood; Interior:

1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
2. Gypsum Wallboard and Wood Primer:
   a. Generic Components:
      1) Minimum 17 percent solids, 100 percent waterborne modified polyamine epoxy or cross-linked water-based acrylic-epoxy; 170 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:

1) Series 151 Elasto-Grip FC (TCI); Sanitile 255 (TCC); 3478 Epoxy Primer/Sealer (SWC): One coat, 0.7 to 1.5 dry mils.

3. Gypsum Wallboard and Wood Finish:
   a. Generic Components:
      1) Minimum 44 percent solids, waterborne acrylic epoxy or water-based epoxy; 250 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide one of the following:
      1) Series 113/114 HB Tneme-Tufcoat (TCI); Sanitile 555 (TCC); 3479 High Performance Epoxy Coating (SWC): Two coats, 4.0 to 6.0 dry mils, per coat.

J. New and Existing Exterior Surfaces of Steel Pipe; Buried Exterior:
   1. Surface Preparation: Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
   2. Primer/Finish:
      a. Generic Components:
         1) Minimum 75 percent volume solids, build, coal tar polyamide epoxy coating; 330 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series 46 Hi-Build H-413 Tneme-Tar (TCI); Bitumastic 300M (TCC); Targuard (SWC): Two coats, 9.0 dry mils, per coat.

K. New and Existing Exterior Surfaces of Ductile Iron Process Pipe; Buried Exterior:
   1. Refer to Section 40 05 19, Ductile Iron Process Pipe.

2.3 CALKING AND SEALANTS

A. Refer to Section 07 92 00, Joint Sealants.

2.4 INSTRUMENTS

A. Instruments:
   1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocksProducts and Manufacturers: Provide the following:
      a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, or equal.
      b. Holiday detector shall be Model M-1 as manufactured by Tinker & Rasor, or equal.
      c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work.

Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified, or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

A. General:
   1. Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.

3.3 PROTECTION OF PROPERTY AND STRUCTURES

A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and painting Work.

B. Use shrouding, vacuum blasting, or other acceptable methods for cleaning and surface preparation of exterior surfaces.

C. During blast cleaning and surface preparation of interior and exterior surfaces, control exhausting of dust and grit using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust and grit from escaping. Similarly, control removal and temporarily store residues to protect adjacent property and structures.

D. For painting of exterior surfaces, use rollers, shrouding, or other acceptable methods as required to protect adjacent property and structures from wind-blown paint residues.

E. Submit proposed procedures for cleaning, surface preparation, and paint application that describe in detail methods to be used to protect adjacent property and structures from residues. Do not proceed with cleaning, surface preparation, or painting until proposed procedures are accepted by ENGINEER.

3.4 MATERIALS PREPARATION

A. General: Mix and prepare painting products in strict accordance with paint manufacturer's product data sheets.

3.5 APPLICATION

B. General:
   1. Apply paint systems by brush, roller, or airless spray per paint manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable, and in strict accordance with paint manufacturer's product data sheets.

2. Surfaces of items not normally exposed-to-view do not require same color as other components of system of which they are a part, but require same painting system specified for exposed surfaces of system.
3. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
4. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint to shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and paint manufacturer's recommended compatible field-applied finishes.
6. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

C. Minimum/Maximum Paint Film Thickness: Comply with manufacturer's published recommendations for coating type and surface.

D. Scheduling Surface Preparation and Painting: Comply with manufacturer's published recommendations for coating type and surface.

E. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to result in a finish coat with no burn-through or other defects caused by insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

G. Brush Application:
1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
2. Brush-apply all primer or first coats, unless otherwise allowed to use mechanical applicators.

H. Mechanical Applicators:
1. Use mechanical methods for applying paint when allowed by applicable ordinances, paint manufacturer, and approved by ENGINEER.
2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.

I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.6 FIELD QUALITY CONTROL

J. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Provide testing instruments specified in Article 2.4 of this Section for testing by CONTRACTOR. Testing instruments shall become property of OWNER.
   1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
   2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.

K. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.

L. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to ENGINEER.

3.7 ADJUSTMENT AND CLEAN-UP

M. Correct damage to work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

N. During progress of the Work, remove from Site all discarded paint products, rubbish, cans, and rags at end of each workday.

O. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

P. At completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

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26 05 05 GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, incidentals, testing, troubleshooting and training as shown, specified, and required to provide complete and operable electrical work.
   2. CONTRACTOR shall obtain written permission from OWNER prior to de-energization of any electrical power on the plant site.

B. Coordination:
   1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions shown on the Drawings that are related to equipment are based on the equipment of one manufacturer. Conform the dimensions of the equipment furnished to the space allocated for that equipment.
      b. The Drawings show the principal elements of the electrical Work. They are not intended as detailed working drawings for the electrical Work, but as a complement to the Specifications to clarify the principal features of the electrical systems.
      c. It is the intent of the Drawings and Specifications that all equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
      d. It also is the intent of the Drawings and Specifications that similar products be provided by the same manufacturer for uniformity on the Project.

D. Area Classifications:
   1. Dry Locations: Materials, equipment, and incidentals in these locations shall meet NEC and NEMA requirements for dry locations. Conduit systems shall be as specified in Section 26 05 33.13, Rigid Conduit. Enclosures, pullboxes, and terminal boxes shall be NEMA 12, unless noted otherwise.

   2. Wet/Corrosive Locations: Materials, equipment, and incidentals in these locations shall meet NEC and NEMA requirements for wet locations. Conduit systems shall be as specified in Section 26 05 33.13, Rigid Conduit. Enclosures, pull boxes, and terminal boxes shall be NEMA 4X Type 316 Stainless Steel, unless noted otherwise.

E. Area Classification Table:

DRY LOCATIONS:
Electrical Rooms Interior locations
WET / CORROSIVE LOCATIONS:
All outdoor locations (above and below grade)

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Electrical Subcontractor shall have a master electrician in his/her employment with a license that was issued by the Texas Department of Licensing and Regulation (TDLR). Name and license number of licensees shall be verifiable on the TDLR website.
   2. Electrical subcontractor shall have a minimum of five years continuous experience in the following:
      a. Low voltage (600V and below) electrical distribution.
   3. Provide a list of three projects of size and scope similar to this project with name and telephone number of client contact if requested by the Owner or Engineer.
   4. Electrical subcontractor shall have a journeyman electrician on the project site at all times while any electrical work is taking place. This includes unloading of equipment and materials. Journeyman license shall be issued by the Texas Department of Licensing and Regulation (TDLR). Name and license shall be verifiable on the TDLR website.
   5. Work performed in this project shall conform with the latest applicable provisions and requirements of the following:
      a. NFPA 70 - National Electrical Code (NEC).
      b. National Electrical Safety Code (NESC).
      c. NFPA 70E - Standard for Electrical Safety in the Workplace.
      d. NFPA 72 - National Fire Alarm Code.

B. Component Supply and Compatibility:
   1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

C. Regulatory Requirements:
   1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.
   2. Codes: Refer to Section 01 42 00, References, for indication of applicable codes.

D. Existing Conditions:
   1. CONTRACTOR shall visit project site and make themselves aware of all existing conditions prior to submitting his/her bid.

1.3 SUBMITTALS

A. General:
   1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
   2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
      b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
      c. List of components including manufacturer's name and catalog number (or part number) for each.
      d. Point-to point interconnection wiring diagrams.
   2. Product Data:
      a. Manufacturer's name and product designation or catalog number.
      b. Electrical ratings.
      c. Manufacturer's technical data and specifications.
      d. Manufacturer's indication of compliance with applicable reference standards.
      e. Painting and coating systems proposed.
   3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.

C. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Installation data and instructions.
      b. Instructions for handling, starting-up, and troubleshooting.
   2. Source Quality Control Submittals: Results for required shop testing.
   3. Field Quality Control Submittals: Results for required field testing.
   4. Qualifications:
      a. Electrical Subcontractor.

D. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. System Record Drawings: Include the following:
         1) One-line wiring diagram of the electrical distribution system.
         2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
         3) Layouts of the power and lighting arrangements and the grounding system.
         4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.

PART 2 – PRODUCTS

A. Refer to individual Division 26 equipment specifications.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
   2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
   3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

B. Staging, Sequencing, and Coordination with Existing Facilities:
   1. Schedule, sequence, and install materials and equipment in accordance with Section 01 14 16, Coordination with Owner's Operations
   2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by OWNER.
   3. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01 14 16, Coordination with Owner's Operations, unless otherwise allowed by OWNER.
   4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.
   5. Interruptions of existing circuits, not addressed in Section 01 14 16, Coordination with Owner's Operations, shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control – General:
   1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:
   1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
   2. Perform the following operational tests on electrical systems:
      a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.
      b. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
      c. Operate lighting systems and receptacle devices to verify proper operation and connections.
   3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.

C. Manufacturer's Services:
   1. Furnish qualified, factory-trained representative(s) of equipment manufacturers at the Site for the services indicated in the Contract Documents.

+ + END OF SECTION + +

26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling as shown on the Drawings.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B3 - Specification for Soft or Annealed Copper Wire.
   3. ASTM B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   4. ASTM D3485 - Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
   5. ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
   6. NEMA TC 7 - Smooth Wall Coilable Electrical Polyethylene Conduit.
   7. UL 44 - Thermoset-Insulated Wires and Cables.
   8. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 300, Wiring Methods.
   2. NEC Article 310, Conductors for General Wiring.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer’s literature, specifications, and engineering data for low volt cable proposed for use.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals:
      a. Records of field insulation resistance test results.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Insulated Cable in Raceways:
   1. Material: Single tinned copper conductor complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW/XHHW-2 complying with UL 44.
   2. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
   3. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.
   4. Manufacturers: Provide products of one of the following:
      a. Southwire.
      b. General Cable.
      c. Encore Wire Corporation.
      d. Or equal.

B. AFD Cable:
   1. Application: Use between low voltage (less than 600V) AFDs and their associated motors.
   2. Manufacturers: Provide products of one of the following:
      a. Service Wire Co.
      b. General Cable.
      c. Belden.
   3. Description: Three tinned copper conductors insulated with 2000V XLPE insulation with three symmetrically placed ground wires cabled together and covered with 5 mil copper tape shield, wrapped with 50% overlap. PVC jacket covering tape shield.
   4. Compliances:
      a. UL 1277 Type TC-ER, 2000V.
      b. UL File # E57179.
      c. UL Type RHH or RHW-2 conductors per UL 44.
      d. IEEE 383.
      e. IEEE 1202.
   5. Wire sizes: 12 AWG to 500 kcmil. Provide size shown on conduit schedule.
   6. Stranding: Stranded only.

C. Cable Connectors, Solderless Type:
   1. Products and Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.
      b. Burndy Hylug.
      c. Or equal.
   2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
   3. For wire sizes, up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
   4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.

5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

D. Cable Splices:
   1. Products and Manufacturers:
      a. Compression-Type Splices: Provide one of the following:
         1) Burndy Hylink.
         2) T&B Color-Keyed Compression Connectors.
         3) Or equal.
      b. Spring Connectors: Provide one of the following:
         1) Buchanan B-Cap.
         2) T&B Wire Connector.
         3) Or equal.
   2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
   3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
   4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
   5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

E. Wire and Cable Markers:
   1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
   3. Use dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to minimum of six times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
   1. Where possible, install cable continuous, without splice, from termination to termination.

2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
3. Splices are not allowed in conduits.

F. Identification:
1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Identify power conductors by circuit number and phase at each terminal or splice location.
3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:
1. No. 8 AWG and Smaller: Provide colored conductors.
2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:
1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in

service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.

4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.

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26 05 23 INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
   2. Types of cables include the following:
      a. Shielded instrumentation cables.
      b. Data communication cables.

B. Related Sections:
   1. Section 26 05 33.13, Rigid Conduits.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 13 - Power-Limited Circuit Cables.
   2. UL 1581 - Electrical Wires, Cables and Flexible Cords.
   3. UL VW-1 - Vertical Wire Flame Test.
   4. UL 910 - Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
   2. NEC 800, Communications Circuits.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Single Shielded Pair Instrument Cables:
   1. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.
   2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581. Temperature rated 90 degrees C in dry locations and 75 degrees C in wet locations.
   3. Shielded pair cable uses abbreviation "TSP" on the Drawings.

B. Multi-Conductor (Triad) Shielded Instrument Cables:
   1. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.
   2. Tinned copper, three XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581. Temperature rated 90 degrees C in dry locations and 75 degrees C in wet locations.
   3. Shielded triad cable uses abbreviation "TST" on the Drawings.

C. Ethernet Cable:
   1. 24 AWG stranded (7 x 32) bare copper conductors, bonded pairs, polyolefin insulation, polyester separator, aluminum polyester shield (100% coverage), drain wire, industrial grade sunlight and oil resistant PVC jacket. Sequential making at two foot intervals.
   2. Manufacturers and model: Provide one of the following:
      a. Belden 7939A.
      b. or equal.
   3. This cable type shall be designated as "ENET CABLE" on the Drawings.

D. Cable Terminals:
   1. Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.
      b. Burndy Insulug.
      c. Or equal.
   2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install cables complete with proper terminations at both ends.
   2. Install in conduit separate from power cables, unless shown or indicated otherwise.
   3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
   4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
   5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
   6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
   2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
   3. Replace with new cables the full length of cables that fail test.
   4. Test equipment shall be provided by CONTRACTOR.
   5. For testing of communications cables, test equipment used shall comply with the following:
      a. Equipment shall consist of a "master" and a "remote" unit.
      b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
      c. Test unit shall be capable of storing all test results internally and printing the results later.
      d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.
   6. Test all Ethernet cables with a Fluke DSP100 Cable Meter (or equal) testing system. A qualified factory-trained manufacturer's representative shall certify in writing that the network cabling system has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Certification shall bear the typewritten name and signature of the person responsible for the work. Certification shall state all cables have passed all tests and are ready to be placed into operation. The CONTRACTOR shall provide four (4) copies of the manufacturer's representative's certification

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26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   3. UL 467 - Grounding and Bonding Equipment.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 250, Grounding.
   2. UL Standard #467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for grounding materials proposed for use.
   2. Listing of grounding connector types identifying where they are to be used.
   3. Layouts of each structure ground grid.
   4. Test point construction details.
   5. Results of ground resistance tests at each test point.
      a. Ground resistance test procedure.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Tinned Bare Copper Ground Cable:
   1. Material: Soft drawn tinned bare copper stranded cable conforming with ASTM B8 and B189. Provide size as shown on the Drawings, but in no case less than No. 4 AWG.
   2. Manufacturer: Provide ground cable of one of the following:
      a. Cable Corporation.
      b. General Cable Corporation.
      c. Or equal.

B. Ground Rods:
   1. Material: Stainless steel rod, 3/4-inch diameter, 10 feet long.
   2. Manufacturer: Provide ground rods by one of the following:
      a. Erico.
      b. T&B Blackburn Company.
      c. Or equal.

C. Ground Test Well:
   1. Provide ground test well where shown on the Drawings to measure ground system resistance to ground. Provide per detail shown on the Drawings.
   2. Test well casing shall be heavy duty steel and lid shall be traffic rated cast iron with "GROUND" cast letters.
   3. Ground test well shall be 24" deep and 12" in diameter and shall be Advanced Lightning Technology model 3152 or approved equal.

D. Grounding Connectors:
   1. Material: Compression connectors shall be heavy duty copper. Bolted connectors to be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections to be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
   2. Product and Manufacturer: Provide grounding connectors of one of the following:
      a. Pressure Connectors:
         1) O.Z./Gedney, Division of General Signal Corporation.
         2) Burndy Corporation.
         3) Or equal.
      b. Welded Connections:
         1) Cadweld by Erico Products, Incorporated.
         2) Therm-O-Weld by Burndy Corporation.
         3) Or equal.

PART 3 – EXECUTION

3.1 STRUCTURE GROUND SYSTEM

A. Provide complete grounding system as shown on Drawings and as specified herein.

B. Ground the neutral on the secondary of dry transformers per the following:
   1. Provide a ¾ inch x 10 foot ground rod through a 1 inch diameter cored hole in the concrete floor at the location of each dry transformer.
   2. Connect the transformer neutral to the ground rod with a #4 ground cable.
   3. Extend a #4 ground cable to the closest accessible cold water pipe that extends below the concrete floor and attach cable to pipe with a ground clamp.
   4. Extend a #4 ground cable to the closest accessible steel building column and attach cable to column with an exothermic weld.
   5. Bond the secondary of the dry transformer secondary neutral to the transformer ground bus and enclosure with a #4 ground cable.

C. Do not ground neutrals at points other than those stated above.

D. Weld all buried connections except at test wells.

3.2 EQUIPMENT GROUNDING

A. Ground all electrical equipment in compliance with the National Electrical Code.

B. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.

C. Connect to piping with ground clamps. Use tinned copper bonding jumpers on gasketed joints.

D. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use anchor bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.

E. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.

F. Connect to service water piping by means of copper clamps. Use tinned copper bonding jumpers on gasketed joints.

G. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.

3.3 TESTING

A. Test the completed ground system at the ground test well of the ground mat for resistance to ground using an electrical ground resistance tester. The grounding system maximum resistance shall not exceed 5 ohms under normally dry conditions when measured by the resistance tester. Resistance values above 5 ohms shall be brought to the ENGINEER'S attention.

B. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive when installing additional ground rods to increase their effectiveness.

C. Test all grounded cables and metal parts for continuity of connection.

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26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systemns.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   3. Section 26 05 33.13, Rigid Conduits.

1.2 REFERENCES

A. Standards referenced in this section are:
   1. ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A1011/A1011M - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detail dimensions.
   2. Bills of Materials.
   3. Manufacturer’s name, product designation, and catalog number.

B. Product Data:
   1. Copies of manufacturer’s specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed.
   2. Pictorial views and corresponding identifying text of each component proposed for installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. B-Line.
   2. Kindorf.
   3. Unistrut.
   4. Or equal.

2.2 MATERIALS

A. Strut, Fittings, and Accessories:
   1. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
   2. Provide 12-gauge Type 316 stainless steel at all locations.
   3. Provide 316 stainless steel plates, fittings, fasteners, etc

B. Hanger (all thread) Rods:
   1. Provide 316 stainless steel minimum 3/8-inch diameter.

C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:
   1. Provide 316 stainless steel beam clamps with 316 stainless steel bolts and other fasterners.

D. Concrete Anchor Bolts:
   1. Provide 316 stainless steel minimum 3/8-inch diameter.

2.2 MANUFACTURERS

A. Provide products of one of the following:
   1. B-Line.
   2. Superstrut.
   3. Unistrut.
   3. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install supporting systems with all necessary channels, fittings, brackets, and related hardware for mounting and supporting equipment. Include anchor bolts, concrete anchor bolts and associated hardware for proper support of equipment.

B. Equipment and devices shall be installed on supporting systems as shown on the Drawings, specified, or required.

C. Install supporting devices level, parallel, and perpendicular to building walls and floors, such that the support system is installed in a neat and professional manner.

D. Holes in suspended ceilings for support rods and other equipment shall be made adjacent to bars where possible to facilitate removal of ceiling panels.

E. Installation of supporting systems shall be coordinated with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment, and located clear of interferences and access ways.

F. Mounting of Conduit:

1. A minimum of 1/4-inch space shall be provided between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
2. Conduit shall be fastened to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.

G. Install conduit supports and fasteners per Section, 26 33 13.33, Rigid Conduits.

H. Mounting of Cabinets, Consoles, Panels, Enclosures, and Boxes:
1. Freestanding: Unless otherwise specified or shown on the Drawings, floor mounted equipment, cabinets, consoles, panels, enclosures, and boxes shall be installed on 4-inch high concrete equipment base with a 45 degree chamfered edge. The base shall extend two inches beyond outside dimensions of equipment, all sides.
2. Wall Mounted:
   a. A minimum 1/4-inch space shall be provided between cabinets, consoles, panels, enclosures, or boxes and the surface on which they are mounted. Non-metallic or stainless steel spacers shall be provided as required.
   b. Equipment, enclosures, panels, and boxes shall not be mounted directly to beams or columns. Struts shall first be mounted to beams or columns using beam clamps and equipment, enclosures, panels, and boxes shall be mounted to the struts.
3. Floor Stand Rack:
   a. Where equipment, cabinets, consoles, panels, enclosures, or boxes cannot be wall mounted, provide an independent floor stand rack.
   b. Rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended equipment.
   c. Rack shall be equipped with brackets and bases for rigidly mounting the framework to the ceiling or floor, or equipped with beam clamps, angle plates, washers, and bolts for fastening to beam flanges.
   d. When the equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
      1) The main vertical supports of floor stand rack assemblies shall be back-to-back struts.
      2) Bracing, clamping and anchoring of each rack shall be sufficient to ensure rigidity of the rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, or wireway installed. Racks shall not be deflected more than 1/8-inch by a 100 pound force applied at any point on the rack in any direction.

I. Drilling into beams or columns is not allowed except as authorized by ENGINEER.

J. All nuts and bolts shall be tightened to the following values:

Bolt Size	**Torque (ft-lbs)**
1/4” – 20	6
5/16” – 18	11
3/8” – 16	19
1/2” – 13	50

K. Field Cutting:

1. Cut edges of strut and hanger rod shall have corners rounded, edges beveled and burrs removed. If field cutting the strut is required, use only clean, sharp, dedicated tools. Oil, shavings, and other residue of cuttings shall be removed prior to installation.

+ + END OF SECTION + +

26 05 33.13 RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
   2. When specific, detailed conduit routings for various systems within buildings and other areas are not be shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.

B. Coordination:
   1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.

C. Provide conduit types as follows:
   1. Underground: Schedule 40 PVC conduit, concrete encased.
   2. Embedded in concrete floor of buildings: Schedule 40 PVC conduit.
   3. Aboveground indoors (exposed): Rigid aluminum conduit.
   4. Aboveground outdoors: PVC coated rigid aluminum conduit.

D. Related Sections:
   1. Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI C80.5 - Standard for Rigid Electrical Aluminum Conduit.
   2. ANSI/NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
   3. NEMA TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   4. NEMA TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   5. NEMA TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   6. UL 6A - Electrical Rigid Metal Conduit – Aluminum.
   7. UL 514B - Conduit, Tubing, and Cable Fittings.
   8. UL 651 - Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
   9. UL 886 - Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 344, Rigid Metal Conduit.
   2. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. When requested by the ENGINEER, provide assembly details of conduit racks and other conduit support systems.
      b. When requested by the ENGINEER, provide layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, water stops, and other features of the slab.
   2. Product Data:
      a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
   2. Site Quality Control Submittals:
      a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.

C. Closeout Submittals: Submit the following:
   1. Record Drawings:
      a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Rigid Aluminum Conduit, Elbows, and Couplings:
   1. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
   2. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Or equal.

B. PVC-coated Rigid Aluminum Conduit, Elbows, and Couplings:

1. Material: Rigid, heavy-wall aluminum, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
2. Color: Color of coating shall be the same on all conduit and fittings.
3. Manufacturers: Provide products of one of the following:
    a. Robroy Industries.
    b. Perma-Cote Industries.
    c. OCAL, Inc.
    d. Or equal.

C. Rigid Aluminum Conduit Fittings, and Conduit Bodies:
1. Material and Construction: Cast aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Conform to ANSI/NEMA FB1 and be listed by UL. Provide conduit bodies stamped with permissible conductor combinations. Provide a conduit body rated for the conductor combination at the location where the unit will be installed. Conduit bodies shall be gasketed and watertight at all installation locations.
2. Rigid aluminum conduit fittings shall be of the threaded type only. Provide threaded couplings between each section of rigid aluminum conduit. Each rigid aluminum conduit that terminates into a box, enclosure, etc shall terminate into an aluminum threaded hub fitting. Threaded hub fittings shall have insulated throats and shall be Myers Scru-Tite or equal. Locknut terminations of rigid aluminum conduits will not be allowed.
3. Manufacturers: Provide products of one of the following:
    a. Crouse-Hinds Company.
    b. Appleton Electric Company.
    c. Or equal.

D. Rigid Nonmetallic Conduit and Fittings:
1. PVC Plastic Conduit:
    a. Manufacturers: Provide products of one of the following:
        1) Cantex.
        2) Carlon.
        3) Certainteed.
        3) Or equal.
    b. Material: Schedule 40 PVC, rated for 90 degrees C, conforming to NEMA TC3 and UL 514B and 651.
    c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

E. Conduit Hubs:
1. Manufacturers: Provide products one of the following.
    a. Myers Electrical Products Company.
    b. Or equal.
2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.

3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.

F. Conduit Bushings and Locknuts:
   1. Manufacturers: Provide products one of the following:
      a. O-Z/Gedney.
      b. Appleton Electric Company.
      c. Or equal.
   2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with 316 stainless steel clamping screw. Provide with bronze grounding lug, as required.
   3. Locknuts: 316 stainless steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
   4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

G. Thruwall Seals:
   1. For new construction through exterior subsurface walls and exterior concrete walls.
      a. Manufacturer: Provide one of the following:
         1) Type WSK and WSCS by O-Z/Gedney.
         2) Or equal.
   2. For new construction passing through concrete floors and floor slabs.
      a. Manufacturer: Provide one of the following:
         1) Type FSK and FSCS floor seals by O-Z/Gedney.
         2) Or equal.
   3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
      a. Manufacturer: Provide one of the following:
         1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
         2) Or equal.

H. Seal Fittings:
   1. For conduits passing through classified areas.
   2. Materials and Construction: Cast gray iron alloy, cast malleable iron or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish. Ample opening with threaded closure for access to conduit hub for making dam. In corrosive locations, fittings shall include factory-applied 40-mil thick PVC coating.
   3. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished, shall be products of fitting manufacturer and shall conform to UL 886.
   4. Manufacturer: Provide one of the following:
      a. Crouse Hinds Company.
      b. Appleton Electric.
      c. Or equal.

2.2 ACCESSORIES

A. Fasteners: Provide 316 stainless steel fasteners only.

B. Duct Sealing Compound
   1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
   2. Remains workable at all temperatures.
   3. Manufacturer:
      a. Type DUX by O-Z/Gedney.
      b. Or equal.

2.3 IDENTIFICATION

A. Conduit Labels:
   1. Provide conduit tags in accordance with Section 26 05 53, Identification for Electrical Systems.

B. Warning Tape:
   1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Provide threaded fittings and connections only for couplings, terminations, etc. Set screw type fittings will not be permitted for rigid aluminum conduit. Provide oxidation inhibitor, Noalox, Penetrox or equal coating on all threaded connections.

B. Install conduits in conformance with Laws and Regulations.

C. Supports:
   1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

D. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.

E. Exposed Conduit:
   1. Install parallel or perpendicular to structural members or walls.
   2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
   3. Install on structural members in protected locations.
   4. Locate clear of interferences.
   5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
   6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.

F. Conduit Embedded in Structural Concrete:
   1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
   2. Before placing concrete, arrange for observation of conduit installation by RPR or ENGINEER and make necessary conduit location measurements and provide required information on record documents.
   3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
      a. Minimum concrete thickness shall be as follows:
         1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
         2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
         3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.
      b. Conduit spacing shall be as follows:
         1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
         2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
         3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit

G. Underground Conduits:
   1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
   2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Division 31.
   3. Install warning tape 12 inches below finished grade over buried conduits.

H. Empty Conduits:

1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.

I. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

J. Joints:
   1. Apply conductive compound to joints before assembly.
   2. Make up joints tight and ground thoroughly.
   3. Use standard tapered pipe threads for conduit and fittings.
   4. Cut conduit ends square and ream to prevent damaging wire and cable.
   5. Use full threaded couplings. Split couplings are not allowed.
   6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.

K. Terminations:
   1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
   2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
   3. Use of bushings in lieu of locknuts is not allowed.
   4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

L. Moisture Protection:
   1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
   2. Underground and embedded conduit connections shall be watertight.
   3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
   4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
   5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.
   6. Dissimilar Metals:
      a. Prevent occurrence of electrolytic action between dissimilar metals.
      b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
      c. Back paint aluminum in contact with masonry or concrete with two coats of bituminous paint.

M. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.

N. Non-metallic Conduit:
   1. Install in accordance with manufacturer's recommendations.
   2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
   3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
   4. Transition to PVC-coated rigid aluminum conduit before making turn up to enclosures.

O. PVC-coated Rigid Aluminum Conduit:
   1. Install in accordance with manufacturer's recommendations.
   2. Install with manufacturer's installation tools to avoid damage to PVC coating.
   3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.

P. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

Q. Seal fittings: Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
   2. Maintain a record, by number, of all conduits successfully tested.
   3. Repair or replace conduits that do not successfully pass testing, and re-test.

+ + END OF SECTION + +

26 05 33.16 FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEC Article 351 - Liquid-Tight Flexible Metal Conduit.
   2. UL Standard No. 360 - Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Flexible Conduit:
   1. Material: Flexible aluminum core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 2 inch. Material shall be UL listed.
   2. Product and Manufacturer: Provide one of the following:
      a. Anaconda Sealtite EFL.
      b. Or equal.

B. Flexible Conduit Fittings:
   1. Material and Construction: Aluminum with standard finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where

equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with the Laws and Regulations.

END OF SECTION

26 05 33.33 PULL, JUNCTION AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. NEC Article 370 - Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50 - Electrical Cabinets and Boxes.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull and junction boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pull, Junction and Terminal Boxes:
   1. General:
      a. Boxes shall be rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
   2. Material and Construction.
      a. Welded steel sheets of USS gauge.
      b. Oil-resistant gasket.
      c. Lift-off hinges and quick-release latches.
      d. Boxes with any dimension 24 inches and smaller shall be 14 gauge. Boxes with any dimension larger than 24 inches shall be 12 gauge, except use 10 gauge on boxes with any dimension of 36 inches or more.
   2. Manufacturer: Provide boxes manufactured by one of the following:
      a. Hoffman Engineering.
      b. Appleton.
      c. Crouse-Hinds.

d. Or equal.

B. Terminal Blocks:
   1. Material and Construction:
      a. NEMA rated nylon modular terminal blocks.
      b. 600 volt rated.
      c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
      d. Power terminals shall be copper and rated for the circuit ampacity.
   2. Manufacturer: Provide terminal blocks of one of the following:
      a. Allen-Bradley Company, Bulletin, 1492.
      b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.

C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
   1. Conduit runs containing more than three 90-degree bends.
   2. Conduit runs exceeding 200 feet in length.

D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.

E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.

F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.

G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

26 05 43.13 UNDERGROUND DUCT BANKS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install the underground duct bank system shown on the Drawings.

B. Coordination:
   1. Proposed duct bank routing shown on the Drawings is diagrammatic. CONTRACTOR shall field verify the routing of all underground duct banks prior to installation and modify routing as necessary to avoid piping and underground utilities at no additional cost to the OWNER. Alternate routing paths shall be submitted to the ENGINEER for approval.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground duct bank Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 20 00, Concrete Reinforcing.
   3. Section 03 30 00, Cast-in-Place Concrete.
   4. Section 26 05 26, Grounding and Bonding for Electrical Systems.
   5. Section 26 05 53, Identification for Electrical Systems.
   6. Section 26 05 33.13, Rigid Conduits.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layouts showing proposed routing of duct banks and locations of manholes, handholes, and areas of reinforcement.
      b. Typical cross sections for each duct bank.
      c. Duct bank spacer specifications.

B. Closeout Submittals: Submit the following:
   1. Record Drawings:
      a. Indicate actual routing of underground duct bank sections on record documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Raceways: Provide Schedule 40 PVC conduit for underground raceways. Provide PVC coated rigid aluminum conduit for all conduit turn ups. All conduit and fittings shall be

provided in accordance with Section 26 05 33.13, Rigid Conduits. Minimum underground raceway size shall be 2 inches.

B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05, Excavation and Fill. Clean adjacent road surfaces after backfilling and provide dust control measures.

C. Duct Bank Reinforcement: Provide in accordance with Section 03 20 00, Concrete Reinforcing.

D. Concrete: Provide duct bank concrete in accordance with Section 03 30 00, Cast-in-Place Concrete. Red dye shall be provided in concrete mix to provide red coloring throughout entire duct bank installation.

E. Grounding: Provide duct bank ground cable as shown on the Drawings and in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems. Duct bank ground wire size shall be #4/0 AWG.

F. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes. Spacers shall be located in maximum four foot intervals and provide minimum two inch clearance between conduits.

G. Duct Sealing Compound:
   1. Products and Manufacturers: Provide one of the following:
      a. O-Z/Gedney, Type DUX.
      b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Excavation and Backfilling:
   1. Provide excavation and backfilling for duct bank installation in accordance with Section 31 23 05, Excavation and Fill.
   2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can prevent adequate compaction of backfill or that can damage or contribute to corrosion of raceways and cables.

B. Duct Bank Layout:
   1. Top of duct bank concrete shall be a minimum of 24 inches below grade, unless otherwise indicated on the Drawings.

2. Slope duct bank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.

C. Duct Bank Assembly:
   1. Assemble duct banks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch concrete separation between outer surfaces of each conduit. Provide side forms for each duct bank.
   2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.

D. Concrete Placing:
   1. Provide minimum four-inch concrete covering on each side, top, and bottom of concrete envelopes around conduits. Concrete covering shall be as shown or indicated on the Drawings.
   2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire duct bank, including top and bottom, shall be dyed.
   3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.

E. Conduit Transitions:
   1. Conduit installations shall be watertight throughout entire length of duct bank.
   2. Transition from non-metallic to metallic conduit where duct banks enter structure walls and slabs.
   3. Terminate conduits in insulated grounding bushings.
   4. Continue routing of conduits within buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
   5. If raceways are not concrete-encased, provide expansion and deflection fittings in accordance with Division 26.
   6. Plug and seal all empty spare conduits entering structures and manholes. Conduits in use entering structures shall be sealed watertight with duct sealing compound.

F. Duct Bank Reinforcing:
   1. Provide reinforcing for all duct banks as shown or indicated on the Drawings.
   3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.

G. Connections to Structures:
   1. Firmly anchor duct banks to structure walls or slabs. Epoxy-grout duct bank rebar into structure concrete to eliminate sheer forces between duct bank and structure wall concrete.
   2. Duct bank penetrations through structure walls shall be watertight.

H. Grounding:
   1. Provide bare stranded copper duct bank ground cable in each duct bank envelope. Ground connection shall be electrically continuous throughout entire duct bank system.

2. Connect ground cable to all building grounding grids and equipment ground buses. Connect ground cable to all metallic conduit extensions of underground duct bank system.
3. Provide ground clamp and bonding of each metallic conduit extension to maintain continuity of ground system.
4. Terminate ground cable at last manhole or handhole for outlying structures.

I. Detectable Underground Warning Tape:
1. Provide detectable underground warning tape over the full length of each underground duct bank. Tape shall comply with Section 26 05 53, Identification for Electrical Systems.
2. Install warning tape approximately 12 inches below grade.
3. Provide multiple tape sections across the width of each duct bank. Locate center of a warning tape above each edge of duct bank, and at intervals across top width of duct bank so that clear space between tapes does not exceed six inches.

J. Installation at Existing Roadways:
1. Sawcut existing concrete pavement to minimize excavation needed for routing duct banks across roadways. Restore concrete pavement to its previous condition upon completion of the duct bank installation.

K. Reusing Existing Raceways:
1. Pull rag swab through raceway to remove water and clean prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through raceway to remove obstructions if necessary.

+ + END OF SECTION + +

26 05 43.23 MANHOLES AND HANDHOLES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install manholes and handholes as shown on the Drawings.

B. Coordination:
   1. Coordinate manhole and handhole installation with piping, sheeting other excavation supports, and other Underground Facilities, and locate clear of interferences.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before manhole and handholes.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 20 00, Concrete Reinforcing.
   3. Section 03 30 00, Cast-in-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO, Specifications for Highway Bridges.
   2. ANSI A14.3, Fixed Ladders – Safety Requirements.
   3. ANSI/SCTE 77, Specification for Underground Enclosure Integrity.
   4. ASTM A48/A48M, Specification for Gray Iron Castings.
   5. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   6. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections.
   7. ASTM C1028, Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   8. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. All precast manholes and handholes shall be manufactured in a National Precast Concrete Association (NPCA) certified facility.
   2. Obtain all manholes and handholes furnished under this Section from a single Supplier, unless otherwise acceptable to ENGINEER.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Manholes: Provide drawings indicating the following:

1) Interior and exterior dimensions.
2) Elevation drawings including locations of wall penetrations.
3) Details of typical openings, jointing, inserts, and reinforcing.
4) Sump pump product data and system installation drawings/details.

b. Covers and Frame Assemblies: Provide details of construction with anchorage requirements and accessory items.

c. Handholes: Submit schedule of handholes to be furnished and dimensions and pertinent data for each.

d. Layout of Manhole Electrical Systems: Where manholes have extensive electrical systems and supports for electrical systems, submit for each plans, sections, and details indicating proposed layout of such materials and equipment in each manhole.

2. Product Data:

a. Manufacturer's technical information, specifications, and literature for manholes, handholes, castings, and accessories proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:

1. Manholes and handholes shall be precast concrete construction with an AASHTO H-20 load rating. Raceway entrances shall be sized accordingly and located to suit the duct bank installation.
2. Provide minimum interior dimensions of 4' x 4' x 4' for all manholes and minimum interior dimensions of 3' x 3' x 3' for all handholes. Provide a 12" x 12" x 6" deep sump in manhole/handhole floor.
3. Manufacturer: Provide products of one of the following:
   a. Old Castle.
   b. Or equal.

B. Material and Construction:

1. Except where otherwise specified, precast manhole components shall consist of reinforced concrete pipe sections specially designed and constructed for use as manholes and manufactured in accordance with ASTM C478, except as modified in this Section.
2. Precast, reinforced concrete manhole bases, riser sections, flat slabs, and other components shall be manufactured by wet-cast methods, using forms that provide smooth surfaces free of irregularities, honeycombing, and other imperfections.
3. Joints between manhole components shall be tongue-and-groove type employing a single, continuous rubber O-ring gasket. Circumferential and longitudinal steel reinforcing shall extend into bell and spigot ends of joint without breaking steel continuity. Joints between base sections, riser sections, and top slabs of manholes six feet in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than six-foot diameter shall have steel bell and spigot rings.
4. Precast manhole components shall:
   a. Have sufficient strength to withstand loads imposed upon them.

b. Be constructed for minimum earth cover loading of 130 pounds per cubic foot, AASHTO H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact.
c. Manhole bases shall have two cages of reinforcing steel in the walls, each reinforcing cage shall be of area equal to that required in the riser sections.
d. Wall thickness shall be not less than five inches.

5. Lifting holes, when provided, shall be tapered. Not more than two lifting holes shall be cast into each section. Provide tapered, solid rubber plugs to seal lifting holes. Lifting holes shall be made to be sealed by plugs driven from the outside face of section only.
6. Point of intersection (P.I.) of ductbank centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in floor of each manhole base and protruding approximately one-inch above finished floor of base.
7. Mark date of manufacture and name or trademark of manufacturer on inside of manhole barrel.

B. Accessories:
1. Frames and Covers:
a. Double leaf, diamond pattern, aluminum cover with heavy duty 316 stainless steel hinges bolted to frame and cover with 316 stainless steel hardware. Provide cover with locking provisions and lifting handles that store flush with covers when not in use.
b. Frame: Extruded aluminum rated for AASHTO H-20 loading.
c. Identification: Marked “ELECTRICAL” in raised two-inch letters.
d. Manufacturers: Provide products of one of the following:
1) East Jordan Iron Works, CHS Series.
2) Inwesco, 4848 Series.
3) Or approved equal.
2. Pulling Irons:
a. Material: Polypropylene coated 1/2 inch diameter cable.
b. Cast in the wall opposite to centerline of each incoming duct bank and 12 inches below centerline of bottom line of raceways.
c. Manufacturers: Provide products of one of the following:
1) MeadowBurke/Bowco.
2) Or equal.
3. Cable Racks:
a. Material: Heavy duty, nonmetallic glass reinforced polymer.
b. Cable racks shall adequately support cables with space allowed for future cables.
c. Each rack shall be a vertical assembly of two-foot cable racks extending from within six inches of manhole roof slab to within six inches of manhole floor.
d. Manufacturers: Provide products of one of the following:
1) Underground Devices.
2) Or equal.
4. Manhole Steps:
a. Material: Polypropylene plastic.
b. Provide bright safety orange colored steps with cone shaped tread and extra tall end lugs. Steps shall be provided in compliance with ASTM D4101 and OSHA requirements.

c. Manufacturers: Provide products of one of the following:
1) MeadowBurke/Bowco.
2) Or equal.

5. Sump Pumps:
   a. Provide 120VAC submersible sump pump within electrical manholes where indicated on the Drawings. Sump pumps shall have integral, automatic on/off float control and shall be provided with a local disconnect switch above grade. Sump pumps shall meet the requirements listed in Section 43 21 43, Submersible Sump Pumps.
   b. Drain line shall be 2" PVC piping routed to facility drain line indicated on Drawings. Provide drain line with true union check valve and isolation ball valve in accordance with Section 40 05 53, Process Valves.
   d. For adjacent installed manholes, provide interconnecting 2" Schedule 80 PVC drain line to manhole housing sump pump. Provide drain lines at bottom elevation of each manhole for adequate drainage.
   e. Submit sump pump system installation details for ENGINEER approval prior to construction.

D. Concrete Pull Boxes:
1. Manufacturer: Provide products of one of the following:
   a. Strongwell, Quazite series.
   b. Or equal.
2. Material: Precast polymer concrete.
3. Duct entrances sized and located to suit ductbanks.
4. Enclosures and covers shall be UL-listed.
5. Enclosures, boxes, and covers shall comply with test provisions of ANSI/SCTE 77 for Tier 15 applications.
6. Covers shall have coefficient of friction of not less than 0.50, in accordance with ASTM C1028.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Excavation and Backfill:
1. Perform excavation and filling required for installing manholes and handholes for electrical systems, in accordance with Section 31 23 05, Excavation and Fill.
2. Provide manholes and handholes on granular subbase course as shown or indicated. If not shown, provide layer of compacted select fill not less than six inches deep on which manhole or handhole for electrical systems will be installed.
3. Carefully set, level, and align manhole bases and handholes at proper grade.

B. Precast Manholes:

1. Set manhole sections vertical with steps and sections in true alignment. Butter the base of each bell or groove end at joints between components with one-to-two proportion cement-sand mortar to provide uniform bearing between components. Seal joints with cement mortar inside and out and trowel smooth to contour of wall surface. Raised or rough joint finishes are unacceptable.
2. Install sections, joints, and gaskets in accordance with manufacturer's recommendations.
3. Tightly seal each lifting hole with solid rubber plug driven into hole from outside of barrel. Fill remaining void with one-to-two proportion cement-sand mortar.

C. Manhole and handhole structures shall be watertight. Provide foam sealant to seal all penetrations into manholes and handholes for electrical systems.

D. Cable Supports in Manholes:
1. Attach cable racks with three-inch by 3/8-inch diameter "tamp-in" studs mounted in one-inch holes drilled into walls of manholes in absence of inserts.
2. Provide supports for each cable along the cable run within manholes.
3. Individually support each cable at each support on porcelain insulators. Provide sufficient slack for each cable.
4. Securely tie each cable in place at each insulator to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with nylon straps or non-metallic 3/4-inch strapping tape manufactured by 3M, or equal.

E. Grounding:
1. Provide 3/4-inch by 10-foot copper-clad ground rod adjacent to each manhole with #4/0 AWG conductor routed into manhole for bonding with duct bank ground conductors and all other grounding connections within the manhole.
2. Bond all exposed metal manhole accessories and concrete reinforcing rods with #4 AWG minimum bare copper wire and bond to ground rod and duct bank ground cable.

F. Metal Pull Box:
1. Provide NEMA 4X stainless steel, wall-mounted pull box inside each manhole and handhole for electrical systems where analog signal cables are mixed with power cables.
2. Route conduits for analog cables directly into and out of metal pull box so that analog cables are not exposed.

G. Grade Rings:
1. Provide grade rings for manholes when required to adjust cover to proper grade. Construct grade ring on manhole roof slab or cone section on which manhole frame and cover will be placed.
2. Height of grade ring shall be as required to bring frame to proper grade and shall not exceed 12 inches in height.

H. Grading at Manholes and Handholes:
1. Unpaved Areas:
a. Install manholes and handholes in unpaved areas as shown or directed by ENGINEER to rim elevation higher than finished grade.

b. Grade the ground surface to drain away from manholes and handholes.
c. Provide fill around manholes and handholes to level of upper rim of manhole or handhole frame, and evenly grade the surface to a one (vertical)-to-five (horizontal) slope to surrounding grade, unless otherwise shown or directed by ENGINEER.

2. Paved or Travelled Areas:
   a. Install manholes and handholes in paved or travelled areas to meet final grade of paved or concrete surface.
   b. In paved areas in state or county highways or municipal streets or roads, manholes and handholes shall be 1/2-inch below elevation of final surface course (also known as top course or wearing course) of pavement.
   c. Manholes and handholes shall not project above finished roadway pavement.
3. CONTRACTOR shall be solely responsible for proper height of manholes and handholes necessary to reach final grade. ENGINEER's review of Shop Drawings and other submittals for manholes and handholes is general in nature. Provide random-length precast manhole riser sections to adjust manholes to accommodate field conditions for final grading and final elevations.

3.3 FIELD QUALITY CONTROL

A. Manholes and handholes for electrical systems shall be free of visible leakage. Inspect each manhole and handhole and repair any leaks.

+ + END OF SECTION + +

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:
   1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 23, Instrumentation and Communication Cable.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the latest applicable provisions and requirements of the following:
   1. NEC Article 110 - Requirements for Electrical Installation.
   2. NEC Article 210 - Branch Circuits.
   3. NEC Article 215 - Feeders.
   4. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
   5. NFPA 70E - Electrical Safety in the Workplace.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Provide a complete description and listing of proposed electrical identification and electrical identification devices on Shop Drawings for associated equipment or systems.
   2. Conduit and wire identification numbering system and equipment signage.

B. Product Data:
   1. Manufacturer's cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Nameplates:
      a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
      b. Size: As required.

c. Letter Size: Minimum 3/16-inch.
d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.
e. For outdoors, provide engraved aluminum nameplates with black lettering as described above.

2. Legend Plates:
a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:
1. Low voltage safety signs shall be pressure sensitive vinyl conforming to 40 CFR 1910.145, 5 inches by 3.5 inches in size, and shall read, “DANGER - 480 VOLTS”.
a. Products and Manufacturers:
1) B-302-86060 by Brady.
2) Or equal.
2. Low voltage markers shall be either pressure sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, “120 VOLTS”, “208 VOLTS”, “120/208 VOLTS”, or “240 VOLTS” as required.
a. Products and Manufacturers:
1) CV442xx by Brady.
2) Or equal.

C. Voltage System Identification Directories:
1. General:
a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
b. Directories shall identify all voltage systems within building or structure.
c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
e. Example Directory Text:

Voltage System Identification		
System	**A, B, C**	**Neutral**
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

D. Conduit Labels:
   1. Provide the following for conduit identification:
      a. Round stainless steel conduit tags manufactured for the purpose stamped with conduit identification information.
      b. Stainless steel band manufactured for the purpose encircling the conduit and passing through an opening in the conduit tag.

E. Wire Identification:
   1. Heat Shrinkable Wire and Cable Labeling System:
      a. Products and Manufacturers: Provide one of the following:
         1) B-341 PS-xxx-2W by Brady.
         2) Or equal.
      b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
   2. Wrap-Around Wire and Cable Labeling System:
      a. Products and Manufacturers: Provide one of the following:
         1) THT-XX-427 by Brady.
         2) Or equal.
      b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

F. Detectable Underground Warning Tape:
   1. Products and Manufacturers: Provide one of the following:
      a. Indentoline by Brady.
      b. Or equal.
   2. Material: Polyethylene or polyester with detectable metal core and polyester underlaminate.
   3. Width: Two inches.
   4. Color and Labeling: Yellow or red with permanently imprinted black letters: “CAUTION – Buried Electric Line”, repeated continuously over full length of tape.

G. Thermal Printing System:
   1. Utilize thermal transfer process to provide non-smearing labels and markers.
   2. Wire and Cable Markers:
      a. Portable, Products and Manufacturers: Provide one of the following:
         1) TLS2200 by Brady.
         2) Or equal.
      b. Desktop, Products and Manufacturers: Provide one of the following:
         1) 200M by Brady.
         2) Or equal.
   3. Cable Markers:
      a. Portable, Products and Manufacturers: Provide one of the following:

1) Handimark by Brady.
2) Or equal.

b. Desktop, Products and Manufacturers: Provide one of the following:
1) Labelizer PLUS by Brady.
2) Or equal.

2.2 FABRICATION

A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment.

B. Engraved Identification Devices (Nameplates and Legend Plates):
1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
5. On switchgear, provide nameplates for each main and feeder circuit including control fuses, and for each indicating light and instrument.
a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
6. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
7. Push Buttons:
a. Provide legend plates for identification of functions.
b. Provide nameplates for identification of controlled equipment.
c. Provide red buttons for stop function.

d. Provide black buttons for other functions.

8. Pilot Lights:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Red	Running, Open
Green	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

9. Selector Switches:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
10. Panel Mounted Instruments:
   a. Provide nameplates for identification of function.
11. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
   a. Provide nameplates for identification.
   b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR"s other submittals. Install nameplates with adhesive.
   c. Interior items requiring nameplates include:
      1) Terminal blocks and strips.
      2) Bus bars.
      3) Relays.
      4) Rear of face-mounted items.
      5) Rear of door-mounted items.
      6) Interior mounted items that require identification when mounted externally.
   d. Circuit Breaker Directory:
      1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
12. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:
   1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
      a. Install rigid safety signs using stainless steel fasteners.
      b. Clean surfaces before applying pressure-sensitive signs and markers.
   2. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.

3. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories
   1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
   2. For panelboards and other branch circuit or feeder distribution equipment provide voltage system identification directory mounted on equipment.
      a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
      b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Arc Flash Hazard Labels:
   1. Provide arc flash hazard labels as required by NEC Article 110 and NFPA 70E. Arc flash hazard labels shall be provided by the ENGINEER.
   2. Provide labels for motor control centers, switchboards, panelboards, industrial control panels, and all other equipment included in the power system study performed by the ENGINEER.

F. Conduit Labels:
   1. Conduits shall be provided with conduit labels unless otherwise specified.
   2. Flexible conduit shall not be labeled.
   3. Exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment will not be labeled.
   4. Conduit labels shall convey the following information:
      a. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and per approved submittals.
   5. Conduit labels shall be installed at the following locations:
      a. Where conduit enters or exits walls, ceilings, floors, or slabs.
      b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
      c. At maximum intervals of 50 feet along the length of the conduit.
   6. Conduit labels shall be oriented to be readable.

G. Wire and Cable Identification:
   1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
   2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
   3. Do not provide labels for the following:
      a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
   4. Provide wire and cable labels for the following:
      a. New, rerouted, or revised wire or cable.
      b. Insulated conductors.

d. Wire and cable terminations:
    1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
    2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
        a) Label individual conductors in a cable after breakout as specified for wires.
e. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
    1) Label wires or cables within two inches of entrance to conduit.
f. Wire or cable in junction boxes and pull boxes
    1) Label wires or cables within two inches of entrance to conduit.
g. Wire and cable installed in cable tray.
    1) Wire and cable shall have labels at maximum intervals of 20 feet.
h. Wire and cable installed without termination in electrical manholes.
    1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.

5. Wire and Cable Identification System:
    a. Wire and cable labels shall be imprinted with an identifying designator.
        1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
    b. Field Wiring:
        1) Wire or cable designator shall consist of:
            a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
            b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
            c) Remaining characters shall be alphanumeric and make wire designator unique.
            d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
    c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
        1) New Cabinets, Consoles, Panels, and Enclosures:
            a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 40 61 13, Process Control Systems General Provisions.
6. Modified Cabinets, Consoles, Panels, and Enclosures:
    a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.

H. Terminal Strip Labeling:
    1. Label panel side of terminal to match panel wire number.
    2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

+ + END OF SECTION + +

26 05 73 POWER SYSTEM STUDY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to provide a power system study for the electrical system as specified in this Section.
   2. The power system study shall be performed using SKM PowerTools engineering analysis software.
   3. An existing power system study model is available from the ENGINEER and the CONTRACTOR may request a copy through the ENGINEER/OWNER.
   4. The power system study shall include the following:
      a. Equipment provided by the CONTRACTOR under this Project.
      b. Equipment, device ratings, and associated connections to existing WHSPS Pump No. 3.
      c. Latest fault current contribution data, impedances, X/R ratios, etc. of the electrical utility company power system.
      d. Updated arc flash hazard labels for the entire plant electrical system.

1.2 REFERENCES

A. Power system studies shall be performed in accordance with the most current version of the following codes and standards:
   1. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
   2. NFPA 70E, Electrical Safety in the Workplace.
   3. NFPA 70, National Electrical Code.
   4. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
   5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered Professional Engineer legally qualified to practice in the jurisdiction where the Project is located and regularly engaged and experienced in providing engineering services of the kind indicated.
      b. Professional Engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.

B. The CONTRACTOR shall coordinate with the OWNER to obtain all data necessary for the successful development of the power system study model. All data pertaining to

existing equipment and wiring shall be verified by field investigation prior to completing the final study. Protective device information used in the study shall include present settings. If the CONTRACTOR observes conflicting information shown in the Contract Documents during field investigation, the CONTRACTOR shall notify the ENGINEER and OWNER immediately for resolution of the conflict.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Studies:
      a. Calculations and results of the short circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the Professional Engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
      b. Time current curves indicating coordination for protective devices included within the power system studies.
      c. Calculations and results of arc-flash hazard analysis in report format sealed and signed by Professional Engineer retained for the studies.
   2. Field Survey Plan: Submit work plan for field survey and data gathering prior to beginning work. Plan shall indicate the schedule of work, time frames for data collection, and duration that equipment will be temporarily out of service. Submit all shutdown requests for equipment outages in compliance with Division 01 requirements. Provide OWNER minimum two weeks' notice prior to all proposed shutdowns.

B. Informational Submittals: Submit the following:
   1. Qualifications Statements:
      a. Provide qualifications of Professional Engineer performing work for approval.

C. Closeout Submittals: Submit the following:
   1. Final settings of all protective devices. Submit compilation of final settings for all equipment not less than thirty (30) days before programming the associated protective devices.
   2. Electronic Files:
      a. Protective Devices:
         1) Settings for all microprocessor-based protective devices.
         2) Electronic configuration files for use with the manufacturer's software platform for device and protection relay programming.
      b. Power System Studies:
         1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for OWNER's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
         2) Electronic files submitted for OWNER's use shall become OWNER's property.
         3) Source files for power studies performed under this Section.

PART 2 – PRODUCTS

2.1 POWER SYSTEM STUDY

A. General:
   1. Perform a complete short circuit study, protective device evaluation study and protective device coordination study for the electrical distribution system installed under this project. Perform studies in accordance with IEEE 141, IEEE 242 and IEEE 399.
   2. Studies shall include all portions of medium- and low-voltage electrical power distribution systems. Thoroughly cover in the study, normal system operating method and operations that could result in maximum fault conditions.
   3. Perform a complete study to evaluate both new and existing devices and include recommendations on required adjustments. Studies shall include both the normal utility supply and any standby power sources.
   4. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.
   5. Perform both preliminary and final power system studies. The preliminary power system study shall verify adequacy of equipment's short circuit ratings and establish preliminary settings required prior for energizing equipment. The final power system study shall include arc flash hazard analysis. Perform final power system study after ENGINEER's acceptance of preliminary study, but not later than the date when equipment installed under the Project is placed into service. Study data shall include the following:
      a. Preliminary Power System Study: Base the evaluation on utility-confirmed contribution. Base the evaluation on estimated cable lengths, and proposed equipment and protective devices.
      b. Final Power System Study: Base the evaluation on utility-confirmed contribution. Base the evaluation on actual confirmed cable lengths, and installed equipment and protective devices.

B. Short Circuit Study:
   1. Perform short circuit evaluation using computer software specifically designed for such use.
   2. Input data shall consist of the maximum short circuit, single-, and three-phase contributions from the power company primary distribution system, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance and motor contributions, base quantities selected, and other applicable circuit parameters.
   3. Calculate short circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   4. Short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from

each connected branch, including motor back electro-motive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:
   1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short circuit ratings of these devices with the available fault currents.
   2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:
   1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
   2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.
   3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground overcurrent and phase and ground fault protection shall be included, and settings for all adjustable protective devices.
   4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.
   5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
      a. Representative one-line diagram, legends, and types of protective devices selected.
      b. Power company's relays or fuse characteristics.
      c. Significant motor starting characteristics.
      d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
      e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
      f. Relay taps, time dial and instantaneous trip settings.
      g. Cable damage curves.
      h. Symmetrical and asymmetrical fault currents.
   6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc Flash Hazard Analysis:

1. Conduct arc flash hazard analysis after acceptance by ENGINEER of preliminary power system study. Perform arc flash hazard analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following at a minimum:
    a. Bus and protection device name.
    b. Bolted and arcing fault values.
    c. Protective device trip times.
    d. Arc flash boundary, working distance, and incident energy.
    e. Required protective flame-resistant (FR) clothing class.

2.2 STUDY REPORT

A. Summarize results of power system studies in a typed or computer-printed report that includes the following:
    1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
    2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short circuit duties. Evaluation of short circuit calculations and identification of underrated equipment.
    3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
    4. Fault current tabulation including definition of terms and guide for interpretation.
    5. Tabulation of appropriate settings for electronic trip units and protective relays.
    6. Tabulation of equipment survey information.

B. The power system study report shall include a separate section addressing arc flash hazard analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

2.3 ARC FLASH HAZARD LABELS

A. General:
    1. Warning labels shall read, “Warning – Arc Flash and Shock Hazard - Appropriate PPE Required”. Labels shall meet all requirements of NFPA 70E and shall include the following information at a minimum:
        a. Equipment Name.
        b. Flash Hazard Protection Boundary.
        c. Limited Approach Boundary.
        d. Restricted Boundary.
        e. Prohibited Boundary.
        f. Incident Energy Level (calories per square centimeter).
        g. Required Personal Protective Equipment Class.

h. Type of Fire Rated Clothing.

2. Submit a typical arc flash warning label to the ENGINEER for approval.
3. Warning labels shall be adhesive-backed polyester. Warning labels installed in outdoor locations shall be UV resistant.
4. Products and Manufacturers:
   a. Brady.
   b. Or equal.

PART 3 – EXECUTION

3.1 MAINTENANCE OF OPERATIONS

A. Field data collection may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Division 01 requirements.

3.2 INSTALLATION

A. Arc Flash Warning Labels:
   1. Print and install personnel protective equipment labels as required by NFPA 70E and NEC Article 110.
   2. Provide labels for switchgear, switchboards, motor control centers, panelboards and 480V control panels. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

+ + END OF SECTION + +

26 24 13 SWITCHBOARD MODIFICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install switchboards.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA PB2, Dead-Front Distribution Switchboards.
   2. UL 891, Dead-Front Switchboards.
   3. NFPA 70 - National Electrical Code (NEC).
   4. NFPA 70E - Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Where possible, new circuit breakers shall be the product of the original manufacturer of the switchboard in which they are being installed.

B. Modifications shall maintain UL listing of the equipment.

C. Modifications shall be made by a CONTRACTOR specializing in this type of work. Qualifications and experience on past similar projects shall be submitted for approval.

D. Regulatory Requirements: Comply with the following:
   1. NEC Article 408, Switchboards and Panelboards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Components list and nameplate schedule.
      b. Summary sheets with schedules of equipment.

   2. Product Data:
      a. Manufacturer’s technical information, including catalog information.
      b. Manufacturer's technical specifications with assembly and component ratings.

   3. Testing Plans, Procedures, and Testing Limitations:

a. At least thirty days prior to field testing, submit description of proposed testing methods, procedures, and apparatus.

PART 2 – PRODUCTS

2.1 GENERAL

A. Component short circuit ratings shall not be less than minimum rated device in the switchboard. The overall short circuit rating of the existing switchboard shall be maintained. Components shall be rated 600 volts.

B. New devices installed in existing switchboard shall be designed for continuous operation at rated current in a 40 degree C ambient temperature. Follow the manufacturer's recommended clearances and ventilation practices to prevent overheating and to maintain UL listing.

2.2 SWITCHBOARD EQUIPMENT

A. Nameplates:
1. Equipment shall have identifying nameplates in accordance with Section 26 05 53, Identification for Electrical Systems. Provide nameplates for each breaker circuit.

B. Circuit Breakers:
1. Circuit breakers shall be molded case type with quantity of poles, voltage, and current ratings shown.
2. Breakers shall be manually-operated thermal magnetic type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by arc chutes.
3. Breakers shall be operated by a toggle-type handle and shall have quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of breakers shall be clearly indicated by handle position.

4. Provide breakers 400-amp frame and larger with an electronic solid state programmable trip unit. For four-wire power systems and circuits, provide a neutral current transformer, and trip unit shall be suitable to accept neutral input. Provide push-to-trip button on front of circuit breaker to provide local manual means of exercising trip mechanism. Electronic trip system shall include:
a. Plug-in protection programmer, flux shift trip device, and current sensor package. Construct programmer, sensor, and flux-shifting trip device as integral elements of breaker, requiring no externally mounted assemblies for proper operation.
b. Solid state, microprocessor-based, nine-function programmer shall provide true RMS current sensing and include adjustable continuous and instantaneous current elements with adjustable long time, short time, zero sequence ground fault pickup and delay and zone selective interlocking. Main, tie and feeder circuit breakers shall be connected for zone selective interlocking to allow instantaneous bus protection.

7. Where shown, provide breakers with shunt trips, bell alarms, and auxiliary devices.

G. Wiring/Terminations:
   1. Provide small wiring, necessary fuse blocks, and terminal blocks in switchboard as required. Control components mounted in assembly, such as fuse blocks, relays, pushbuttons, switches, and other components, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
   2. Provide mechanical-type terminals for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of size indicated on the Drawings.
   3. Control wire shall be Type SIS, bundled and secured with nylon ties. Provide insulated locking spade terminals for all control connections, except where saddle type terminals are provided integral to a device. Current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to another device. Provide groups of control wires leaving switchboard with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

J. Finishing:
   1. New exterior and interior steel surfaces of switchboard shall be properly cleaned and provided with rust-inhibiting phosphatized coating. Color and finish of new equipment shall match existing color of switchboard..

PART 3 – EXECUTION

3.1 INSTALLATION

A. Modifications to existing switchboards shall be made in accordance with manufacturer's instructions and recommendations. Provide all hardware necessary for installation.

B. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Do not energize equipment without permission of OWNER.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and checks before energizing equipment:
   a. Verify proper installation.
   b. Inspect all mechanical and electrical devices for proper operation.
   c. Check tightness of bolted connections.
   d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
   e. Measure insulation resistance of each circuit breaker, pole-to-pole and from pole-to-ground.
   f. Check for proper anchorage, required area clearances, physical damage, and proper alignment.

g. Clean and lubricate as required.
h. Perform other tests and adjustments recommended by equipment manufacturer.

B. In the event of an equipment fault, notify the OWNER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, ENGINEER and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the ENGINEER prior to placing the equipment back into service.

3.3 ADJUSTING

A. Calibrate, set and program protective devices. Coordinate the protective devices furnished under this Section and provide proper settings of devices per the results of the study specified in Section 26 05 73, Electrical Power Distribution System Studies.

26 29 13.16 REDUCED VOLTAGE SOFT STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment, testing, troubleshooting, training and incidentals as shown, specified, and required to furnish and install complete and operable reduced voltage soft starters (RVSS) as shown on the Drawings.

B. Related Sections:
1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 05 53, Identification for Electrical Systems.
3. Section 26 35 33, Power Factor Correction Capacitors.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. NFPA 70, National Electrical Code (NEC).

1.3 SUBMITTALS

A. Submittal package shall be furnished to the Engineer for approval prior to factory assembly of the RVSS. The submittal package shall consist of the following:
1. Elementary diagrams showing factory power and control wiring along with field wiring connections for line and load power connections and control wiring connections.
2. Outline diagrams showing the overall enclosure and mounting dimensions with front and side views and weights as a minimum. The outline drawings shall also include conduit entry/exit locations along with intended conduit sizes.
3. Voltage, horsepower, current rating, and product features will be furnished from standard catalog sheets.

1.4 INSTALLATION, OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide a copy of installation, operation, and maintenance procedures to owner.

B. Instruction manual shall include programming manuals, wiring diagrams, operating, and maintenance instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer shall have not less than ten years of experience designing and regularly manufacturing and servicing substantially similar equipment to that required and, upon ENGINEER's request, shall submit documentation of not less than five installations in satisfactory operation for not less than five years each.

B. Equipment shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in this specification and shall be 100% factory tested to ensure proper performance.

1.6 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data that indicate performance, dimensions, materials, size, and weight.
   2. Fabrication, assembly, and installation drawings.
   3. Schematic and wiring diagrams.
   4. Complete list of components and catalog identification.
   5. Description of Supplier's quality assurance program.
   6. Complete functional description of system operation.
   7. Heat Dissipation System:
      a. Complete information on heat rejection/cooling system, including fan dimensions, output in standard cubic feet per minute, fan design discharge pressure, and fan manufacturer's literature and specifications, and fan curves.
      b. RVSS heat loss at full load.
   8. Product Data:
      a. Manufacturer's equipment datasheets and technical information.
   9. Testing Plans:
      a. Not less than thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, apparatus, and limitations.
      b. Not less than thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
   2. Field Quality Control Submittals:
      a. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
   3. Manufacturer Reports:
      a. Within five days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
   4. Qualifications Statements:
      a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.

b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
c. Include a listing of all programmable parameters and their settings at Substantial Completion. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on compact disc that can be directly uploaded to the equipment in event of replacement or repair.
d. Comply with Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Packing:
a. Inspect prior to packing to ensure that assemblies and components are complete and undamaged.
b. Protect mating connections.
c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
d. Indoor containers shall be bolted to skids.
2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
3. Handling:
a. Lift, roll or jack equipment into locations shown.
b. RVSS controllers shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

B. Storage and Protection:
1. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

1.6 WARRANTY

A. The manufacturer shall provide a single warranty against faults and defects in material and workmanship for a period of 24 months of operation from the date of successful commissioning. Warranty shall provide for free replacement or repair of parts during that time period including all necessary labor. Warranty shall be administered by the manufacturer or its authorized service representative. A warranty statement including these features shall be provided with submittals and executed versions included as part of the operational and maintenance data.

PART 2 – PRODUCTS

2.1 GENERAL

A. RVSS controllers shall be rated for 115% of the full load amperage of the motor furnished and shall provide power to the motor at all points on its operating curve. RVSS controllers shall be provided with a bypass contactor for operation at full voltage running conditions.
B. Ratings:
1. RVSS controllers shall operate from a 480V three-phase, 60 Hertz system.

2. Interrupting Capacity Rating: Equipment shall have a fault current rating of 65kA RMS symmetrical amperes. All devices and components contained within RVSS enclosure shall be suitable for this rating.

C. Manufacturers: Provide equipment of one of the following:
1. Eaton.
2. Schneider Electric/Square D.
3. Allen-Bradley.
4. Approved equal.

2.2 COMPONENTS

A. Required Features:
1. RVSS shall be microprocessor controlled.
2. Provide subsystems that will protect RVSS from damage due to overcurrent and overvoltage.
3. Field selectable voltage ramp or current limit modes.
4. Adjustable current limit of not more than 300 percent of motor nameplate full-load current throughout entire motor acceleration period including first three cycles of voltage waveform from instant start signal is engaged.
5. Adjustable voltage acceleration, from two to 30 seconds.
6. Adjustable voltage deceleration, from two to 30 seconds.
7. Phase loss and imbalance detection.
8. LED diagnostic indicators.
9. Static overcurrent, undercurrent, and overvoltage trip.
10. Ground fault protection.
11. Phase reversal, line or fuse loss, and under-voltage protection.
12. Power unit over temperature protection.
13. Motor inverse time overload protection.
14. Input line transient over-voltage protection.
15. SCR's shall be connected as inverse parallel pairs in series circuits to attain a 1800V peak inverse voltage for each phase.

B. Operation:
1. On start-up, start driven equipment at zero current and allow to accelerate to maximum speed without exceeding the set current limit.
2. Once driven equipment has reached maximum speed, close bypass contactor.
3. On normal shutdowns, ramp the driven equipment down at the set deceleration rate that is non-regenerative for the motor prior to shutdown.
4. On emergency shutdowns, remove power to motor.
5. The control arrangement shown on the Drawings depicts a typical control, adjusted to reflect the devices required for the operation intended and does not show the bypass control features. The manufacturer standard control shall be adjusted and customized to incorporate the devices shown on the drawing and required for proper operation. Provide controls, status indication and output contacts as shown on the Drawings.

C. Operator Interface Panel:
1. The RVSS shall be supplied with an operator interface keypad/display and diagnostic LEDs for metering and protection display and setting protections setpoints.
2. Keypad shall be divided into 3 functional groups:

a. Graphical display shall two lines of 20 alphanumeric characters each with full text programming. Codes are not accepted.
b. Navigation keys to program starter, display operational data, and faults.

3. The RVSS shall have indication LED's for the following conditions:
   a. ON.
   b. STOP mode.
   c. START mode.
   d. SAVE or SLOW SPEED mode.
   e. RUN mode.
   f. SOFT STOP mode.
   g. FAULT mode.
4. The RVSS shall display operating data, fault information, and programming parameters in English with other languages - Spanish, German and Italian available by parameter setting.
5. The keypad shall display the last 10 faults and provides detailed information on soft starter operating conditions at the time of fault occurrence.
6. Password protection shall be required.

D. Motor Protection Relay:
   1. Where shown on the Drawings, provide a motor protection relay (MPR) mounted within the enclosure as shown on the Drawings. The MPR shall be a multifunction trip unit that monitors phase and ground currents and makes trip decisions from operator selectable protective functions.
   2. Motor protection relay shall have the following characteristics:
      a. Protection and Control:
         1) Phase Instantaneous Overcurrent.
         2) Phase Time Overcurrent.
         3) Ground Instantaneous Overcurrent.
         4) Overvoltage.
         5) Undervoltage.
         4) Current Imbalance.
         5) Resistance temperature detector (RTD) trip for quantity of sensors shown on the Drawings.
         6) Vibration monitoring and trip function. MPR shall accept input from field-mounted vibration monitoring switch.
      b. Monitoring and Metering:
         1) Volts: 0.2 percent accuracy.
         2) Amperes: 0.2 percent accuracy.
         3) Watts, Vars and VA: 0.5 percent accuracy.
         4) Alarm notifications: Relay Trip, Relay Failure.
         5) Ethernet communication capability.
   3. Motor protection relay shall be GE Multilin 469, SEL 710, or equal.

E. Enclosure:
   1. Provide NEMA 1 rated enclosure. The equipment shall be designed for front accessibility only. The maximum dimensions provided shall be 72" (wide) X 42" (deep) X 90" (high). Operator indicators and controls shall be mounted on the door. Cable entry or exist shall be bottom only. No indicator or control shall be lower than 36 inches above the concrete foundation. Provide manufacturer's standard paint system.

2. Include continuous ground bus throughout the RVSS controller assembly, securely connected to the steel frame of each cubicle. Ground connection points shall be available at each end of the lineup.

F. Serial Communication:
   1. Communications protocol shall be RS-232 to a windows based program for data entry, and/or Modbus TCP/IP protocol via RS485 signals.
   2. Units shall be capable of being connected to an intelligent communication device in a network of up to 247 devices with unique addresses.

G. Power Factor Correction:
   1. Power factor correction capacitors (PFCCs) will be provided in a separate enclosure mounted on top of the RVSS enclosure. Refer to Section 26 23 33, Power Factor Correction Capacitors, for more information.
   2. The RVSS shall provide the following for the PFCCs:
      a. Wire lugs between RVSS circuit breaker and the SCR power poles for termination of the power wiring connected to the PFCCs.
      b. Output contacts that control the opening and closing of the capacitor contactor in the power factor correction unit. The contactor shall be open during motor acceleration and shall close after motor acceleration after the SCRs have ceased firing and the motor is directly connected to the power bus.

H. Termination of External Wiring:
   1. Provide mechanical set screw lugs for termination of all power wiring terminating inside of unit. Provide DIN rail mounted terminal blocks for termination of all control wire. Control wire terminal blocks shall be located in one location inside of the unit. Refer to Drawings for sizes and quantities of external wiring to be terminated inside unit. Provide provisions for the input signals entering the unit and provide output signals leaving the unit according to the Drawings.

I. Internal Wiring:
   1. Provide red control wiring and black power wiring inside the unit. Control wiring shall be 14 AWG copper and power wiring shall copper sized according to UL 508A. Control wiring and power wiring shall have a shrink sleeve wire number on each end that corresponds to wire numbers used on manufacturer's drawings.

J. Control Power Transformer:
   1. Control power transformer shall provide power for all of the control components shown on the Drawings. Control power transformer shall be a 480 volt to 120 volt transformer of adequate VA capacity for all of the components that it powers. Provide two fuses on the primary side and one fuse on the secondary side of the unit.

K. Relays and Timers:
   1. Provide manufacturer's standard control relays and timers to implement the control schematic shown on the Drawings.

L. Indicating Lights, Switches and Pushbuttons:
   1. Provide manufacturer's standard indicating lights, switches and pushbuttons to implement the control schematic shown on the Drawings.

M. Print Pocket:
   1. Provide metal print pocket on the interior of the enclosure door. Provide plastic laminated 11 inch x 17 inch copies of all manufacturer drawings pertaining to this unit.

N. Nameplates:
   1. Provide nameplate identifying equipment controlled in accordance with Section 26 05 53, Identification for Electrical Systems. Secure nameplates to the enclosure with machine screws and nuts instead of adhesive mounting. Adhesive mounted nameplates will not be accepted.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work is to be installed and notify OWNER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install at the location shown on Drawings. Install equipment on concrete bases in accordance with the Contract Documents and manufacturer's recommendations and instructions.

B. Do not provide openings in top or side of enclosure.

C. Cable circuits together within enclosures and identify with durable tag secured to plastic cable tie.

D. Verify that wiring diagrams on inside of door of unit reflect the circuitry actually provided and that correct overload heater size is noted.

E. Install in conformance with the manufacturer's recommendations, governing codes, and the Contract Documents.

F. Obtain a copy of the configuration settings that were provided the Power Systems Studies Engineer. Verify that the Field Engineer working in accordance with the Power System Studies Section has installed the configuration settings in the MMR. If the settings are not present, contact the Electrical Subcontractor and have this done.

3.3 FIELD QUALITY CONTROL

A. Perform field testing and inspection of unit. All testing and inspection shall be in accordance with the manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform when equipment is correctly installed. Do not energize equipment without permission of OWNER.

B. Perform the following minimum tests and checks before energizing equipment:
   1. Verify all overload and device settings.
   2. Inspect all mechanical and electrical interlocks and controls for proper operation.

3. Check tightness of bolted connections.
4. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
5. Measure insulation resistance of each starter, phase-to-phase and phase-to-ground.
6. Measure insulation resistance of each control circuit with respect to ground.
7. Perform other tests recommended by equipment manufacturer.

3.4 MANUFACTURER SERVICES

A. Manufacturer Services:
   1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of the equipment and installation in the equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of the equipment.
   2. Manufacturer's factory-trained representative shall test the system as specified in Part 3 of this Section. Representative shall operate and test the system in the presence of OWNER and verify that the equipment conforms to requirements.
   3. Manufacturer's factory-trained representative shall adjust the system to initial settings as specified in Part 3 of this Section.
   4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
   5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
   6. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.

B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01755, Starting Systems.

3.5 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall provide an installation certificate to certify in writing that the equipment has been installed, adjusted, tested and functions in accordance with the manufacturer's recommendations and the Contract Documents.

+ + END OF SECTION + +

26 35 33 POWER FACTOR CORRECTION CAPACITORS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required as shown, specified, and required to determine kVAR rating, and to furnish and install capacitors for power factor correction for the motors indicated.

B. Coordination:
   1. Coordinate sizes of capacitors with nameplate ratings of motors to be furnished.
   2. Consult motor manufacturers of the supplied equipment to obtain written recommendations, including supporting calculations, of the required kilovar ratings of proposed capacitors.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI C55.1, Shunt Power Capacitors.
   2. NEMA CP 1, Shunt Capacitors.
   3. UL Electrical Construction Materials Directory.
   4. UL 810, Capacitors.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 460, Capacitors.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of motors for which capacitors will be provided and proposed kVAR rating for each motor.
      b. Calculations showing corrected power factor for each motor.
   2. Product Data:
      a. Manufacturer's technical information for power capacitors proposed.
      b. Written recommendation from manufacturer for each capacitor in accordance with Paragraph 1.1.B.2 of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING.

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in ample time to avoid delaying the Work.

2. Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Handle and store products in accordance with manufacturer's recommendations and the Contract Documents.

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1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. Obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Materials and Equipment:
1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria
1. Nominal design life of individual capacitor cells shall be 20 years.
2. Capacitors shall be designed and tested in accordance with UL 810, NEMA CP 1, and ANSI C55.1.

B. Performance Criteria and Ratings:
1. System operating voltage shall be as indicated on the Drawings.
2. The kVAR of each capacitor shall be as recommended by associated motor manufacturer to result in an improved power factor of 95 percent for all operating conditions.
3. Capacitors shall be rated for continuous duty at 40 degree C ambient at 3,300 feet elevation and below.
4. Total Harmonic Distortion (THD) of five percent of voltage waveforms shall not affect life of capacitors, contactors, or controller.
5. A variation of plus-or-minus 10 percent in line voltage shall not affect capacitor life.
6. Each assembly shall be furnished with appropriately sized solderless connectors capable of handling conductors in accordance with NEC Article 460. Minimum conductor size shall have capacity of 1.35 times rated capacitor current.
7. To provide for major fault protection, provide line fuses on all three phases of capacitor bank.
   a. Fuses for 10 kVAR units and smaller shall be 100 kAIC rated.
   b. Fuses for 11 kVAR units and larger shall be 200 kAIC rated.

2.2 MATERIALS

A. Individual capacitors shall be self-healing utilizing polypropylene as a dielectric with vacuum deposited conductors on the polypropylene as electrodes. Each three-phase capacitor shall be product listed in UL Electrical Construction Materials Directory and shall be furnished with a pressure-sensitive interrupter. Interrupter shall disconnect all three phases at the same time to maintain a balanced circuit.

B. Capacitors shall be contained in hermetically sealed metal cans to prevent atmospheric contaminants from shortening their useful life. Dielectric material shall be low loss, less than 0.5 watts per kVAR. Encapsulation medium shall be thermosetting polymer resin that allows outgassing to engage the pressure interrupter.

D. Terminal bushings shall withstand 10 kVAC to ground and be rated 30 kV BIL or greater. Capacitor cells shall have threaded terminals for wire connection.

E. Provide capacitors with discharge resistors to reduce residual voltage to less than 50 volts within one minute of de-energization. Resistors shall be rated to ensure 20-year minimum life.

2.3 ENCLOSURE

A. General:
   1. Provide capacitors in a free-standing enclosure mounted on top of the associated reduced voltage soft starter (RVSS) enclosure specified in Section 26 29 13.16.
   2. Furnish panels and enclosures of adequate size to house all equipment, panel mounted devices and associated wiring as required. Enclosure dimensions shall not exceed that of the RVSS enclosure.

B. Construction Features:
   1. The enclosure shall be fabricated from not less than 12 gauge steel, using die-formed, welded and bolted covers in accordance with NEMA and NEC standards. Enclosures shall be NEMA 1 rated with a hinged door and screw cover sides. Use stainless steel fasteners throughout and equip enclosure with grounding lugs. The assembly shall be completely front-connectable and maintainable.
   2. Provide steel print pocket on interior of door.
   3. Provide enclosure mounting supports as required for mounting.
   4. Provide all holes and cutouts for installation of conduit and equipment. Cable and conduit shall enter through the bottom or side of the enclosure. All conduit openings shall be sealed watertight.
   5. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
   6. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surface, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
   7. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.

8. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.
9. All wiring shall be terminated at master numbered terminal strips, unless otherwise specified.

2.4 MANUFACTURERS

A. Provide products of one of the following:
   1. Power System Solutions.
   2. Or equal.

2.5 SOURCE QUALITY CONTROL

A. Tests and Inspections:
   1. Capacitors shall be tested in accordance with UL 810, NEMA CP 1, and ANSI C55.1.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Requirements:
   1. Install capacitors at motor locations, unless otherwise shown or indicated.
   2. Securely fasten equipment to floors, walls, or other structural surfaces on which equipment is mounted.
   3. Provide conduit and wiring between capacitors and motor terminal boxes.
   4. Install in conformance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents.

+ + END OF SECTION + +

31 11 00 CLEARING AND GRUBBING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform clearing and grubbing as shown and specified in the Contract Documents.
   2. The Work includes removing from the Site and disposing of trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material.
   3. Pay all costs associated with transporting and disposing of debris resulting from clearing.
   4. Limits of Clearing and Grubbing: Clear and grub the areas necessary to construct the work as shown or indicated on the Drawings.

B. Related Sections:
   1. Section 01 57 05, Temporary Controls.
   2. Section 02 41 00, Demolition.

1.2 SUBMITTALS

A. Action Submittals: Submit the following
   1. Shop Drawings:
      a. Plan for removing trees and other large vegetation not explicitly shown or indicated for removal in the Contract Documents.
      b. Plan showing proposed limits of clearing and grubbing, if different from clearing and grubbing limits shown or indicated in the Contract Documents.

1.3 WARRANTY

A. CONTRACTOR shall warrant that Work performed under this Section will not permanently damage trees, shrubs, turf, and plants designated to remain, or other adjacent work, facilities, or property. If damage resulting from CONTRACTOR's operations becomes evident during the correction period, CONTRACTOR shall replace damaged items and property at no additional cost to OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. Protection:

1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain (if any), and adjacent property and structures. Repair damage caused by CONTRACTOR to original condition or replace in kind, to satisfaction of ENGINEER, at no additional cost to OWNER.
2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by ENGINEER. Correct at CONTRACTOR's expense damage caused by CONTRACTOR outside the limits of clearing Work.
3. Do not remove trees without approval of ENGINEER, unless shown or indicated for removal.
4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.

B. Site Preparation:
   1. Obtain, pay costs associated with, and comply with applicable permits required for clearing and grubbing Work.
   2. Delineation of Clearing and Grubbing Limits:
      a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
      b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with ENGINEER before commencing removal of trees, vegetation, and other materials to be removed.
      c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and ENGINEER allows removal of flagging.
   3. Erosion and Sediment Controls:
      a. Provide applicable erosion and sediment controls before commencing clearing and grubbing Work.
      b. Comply with Section 01 41 26, Stormwater Pollution Prevention Plan and Permit
      c. Comply with erosion and sediment control requirements of Section 01 57 05, Temporary Controls.
      d. Continue providing erosion and sediment controls as clearing and grubbing Work progresses to previously uncleared, ungrubbed areas of the Site.

3.2 CLEARING AND GRUBBING

A. Remove and dispose of all trees, shrubs, stumps, roots, brush, logs, rubbish, and debris within limits of clearing and grubbing shown or indicated in the Contract Documents, unless otherwise shown or indicated.

B. Trees and Shrubs Improperly Destroyed or Damaged:
   1. For each tree or shrub to remain that is destroyed or damaged beyond repair by CONTRACTOR, provide two replacements of the same species at locations to be designated by ENGINEER.

C. Trees and shrubs to remain shall be protected, and trimmed where required.

D. Salvable Vegetation:
   1. Trees, shrubs, and other vegetation requiring removal to facilitate the Work, and that will be transplanted elsewhere at the Site, shall be carefully balled and burlapped or placed in temporary pots, and stored at the Site in an acceptable area. Work involving removing and relocating trees, shrubs, and other vegetation shall be under the direction of qualified arborist acceptable to ENGINEER, or other professional acceptable to ENGINEER, hired by CONTRACTOR.

E. Disposal of Cleared and Grubbed Materials:
   1. Dispose at appropriate off-Site location trees, stumps, rubbish, debris, and other cleared and grubbed material. Cleared or grubbed materials may remain at the Site only when allowed in the Contract Documents or when approved by ENGINEER in writing. Do not use cleared or grubbed material as fill, backfill, or in embankments.
   2. Dispose of cleared and grubbed material in accordance with Laws and Regulations.
   3. Do not burn clearing debris at the Site, unless approved by OWNER and authorities having jurisdiction. If burning is permitted, comply with requirements of authorities having jurisdiction and Laws and Regulations. If burning is permitted at the Site, also comply with OWNER's requirements.

F. Removal of Site Improvements: Comply with Section 02 41 00, Demolition.

3.3 TOPSOIL REMOVAL

A. Existing topsoil to be removed is defined as friable, clay loam, surface soil present in depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.
B. Stripping:
   1. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.
   2. Do not strip topsoil from within drip line of each tree to remain as part of the completed Project.
C. Stockpile topsoil in storage stockpiles in areas shown, or where otherwise accepted by ENGINEER. Construct storage piles so that surface water drains freely. Stabilize large topsoil piles with a cover crop and mulch. Provide silt fencing around perimeter of pile to prevent topsoil erosion and sedimentation; silt fencing shall be in accordance with Section 01 57 05, Temporary Controls. Cover smaller topsoil stockpiles, when used, with reinforced fabric to prevent windblown dust. Topsoil in excess of the quantity required for the finished Project shall remain property of OWNER.

3.4 ENVIRONMENTAL PROTECTION AND RESTORATION

A. Texas Pollutant Discharge Elimination System (TPDES)
   1. Obtain permit and comply with the state regulations set forth by the Commission of Environmental Quality (TCEQ) Pollutant Discharge Elimination System.

+ + END OF SECTION + +

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31 23 05 EXCAVATION AND FILL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
   2. Preparation of subgrade for slabs and pavements is included under this Section.
   3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.
   4. Fill shall include the refilling and consolidation of the fill on the trenches and excavations up to the surrounding ground surface or road grade at crossing.

B. Related Sections:
   1. Section 03 30 00, Cast-in-Place Concrete.
   2. Section 31 11 00, Clearing and Grubbing.
   3. Section 32 13 13, Concrete Pavement
   4. Section 33 05 05, Buried Piping Installation

C. General:
   1. Conform to Section 01 14 16, Coordination with Owner's Operations.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 522R, Pervious Concrete.
   2. ANSI/AISC 360, Specification for Structural Steel for Buildings.
   3. ASTM C29/C29M, Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
   4. ASTM C33/C33M, Specification for Concrete Aggregates.
   5. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
   6. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   7. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
   8. ASTM C150/C150M, Specification for Portland Cement.
   9. ASTM C595/C595M, Specification for Blended Hydraulic Cements.
   10. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   11. ASTM C989, Specification for Slag Cement for Use in Concrete and Mortars.
   12. ASTM D422, Test Method for Particle-Size Analysis of Soils.
   13. ASTM D448, Classification for Sizes of Aggregate for Road and Bridge Construction.

14. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).
15. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
16. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
17. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
18. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
19. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
20. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
21. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
22. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
23. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
24. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
25. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
26. Texas Department of Transportation “Standard Specifications for Construction of Highways, Streets and Bridges”.
27. North Central Texas Council of Governments (NCTCOG), "Public Works Construction Standards North Central Texas" 5th Edition.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. “Subgrade” is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.
   2. “Embedment” is the fill from the trench bottom to 12-inches above the top of pipes and conduit when laid to grade including the bedding layer sustaining the pipeline as shown on the Drawings.
   3. “Final Backfill” is the backfill above the embedment.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:

a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
b. Responsibilities include but are not necessarily limited to:
1) Reviewing system performance and requirements shown or indicated in the Contract Documents.
2) Preparing written requests for clarifications or interpretations of performance and requirements for submittal to ENGINEER by CONTRACTOR.
3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
5) Certifying that:
a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.

2. CONTRACTOR's Testing Laboratory:
a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
c. Testing laboratory shall be experienced in the types of testing required.
d. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Quality Assurance Testing:
1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
3. CONTRACTOR's Testing Laboratory Scope:
a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
c. Design controlled low-strength material (CLSM) mixes in accordance with requirements of CLSM Article in Part 2 of this Section. Perform concrete materials evaluation tests and testing of CLSM mixes.
d. Submit to ENGINEER and CONTRACTOR written report results of each test.

4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
    a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
    b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
    c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
    d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
    e. CLSM Mix: Verify CLSM mix design by laboratory trial batch, unless indicated otherwise. Perform the following testing on each concrete mix trial batch:
        1) Aggregate gradation.
        2) Flowability, in accordance with ASTM D6103.
        3) Air content, in accordance with ASTM D6023.
        4) Unconfined compressive strength of CLSM mixes at 90 days, in accordance with ASTM D4832.
        5) Submit for each concrete mix trial batch the following information:
            a) Project identification name and number (if applicable).
            b) Date of test report.
            c) Complete identification of aggregate source of supply.
            d) Tests of aggregates for compliance with the Contract Documents.
            e) Brand, type, and composition of cementitious materials.
            f) Brand, type, and quantity of each admixture.
            g) Quantity of water used in trial mixes.
            h) Proportions of each material per cubic yard.
            i) Gross weight and yield per cubic yard of trial mixtures.
            j) Measured flowability.
            k) Measured air content.
            l) Unconfined compressive strength.
    f. Requirement for trial batch may be waived by ENGINEER if sufficient field test data documenting compliance with specified material properties and performance properties is submitted to and accepted by ENGINEER. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures.

C. Regulatory Requirements:

1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
    a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. List of CLSM materials and mix designs proposed for use. Include results of quality assurance testing performed to qualify the materials and to establish the mix designs.
        b. Laboratory Trial Batch Reports: Submit laboratory quality assurance test reports for materials and mix design tests.
        c. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.
    2. Product Data:
        a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures to be used in CLSM mixes.

B. Informational Submittals: Submit the following:
    1. Procedure Submittals:
        a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
            1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.
            2) Excavation method(s) and additional items to be included in the Work, as listed in Paragraph 1.5.B.2.a of this Section.
            3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
            4) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
        b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
    2. Excavation Support Plan and Related Information Prepared by CONTRACTOR's Professional Engineer:
        a. CONTRACTOR and CONTRACTOR's professional engineer shall prepare the following for submittal:
            1) Sheeting and bracing, or other protective system(s) required.
            2) Dewatering system.

3) Underpinning.

b. Drawings and calculations shall be prepared by professional engineer qualified in the specialty involved. ENGINEER's review and acceptance of submittal does not imply approval by ENGINEER of the associated Work. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining the system(s) required to satisfactorily perform all necessary sheeting, bracing, protection, underpinning, and dewatering.

3. Delivery Tickets:
   a. Copies of delivery tickets for each load of CLSM material delivered to or mixed at the Site. Each delivery ticket shall contain information in accordance with ASTM C94/C94M along with project and contract name and number, date, mix type, mix time, quantity and amount of water introduced.
4. Quality Assurance Test Results Submittals:
   a. Submit results of quality assurance testing performed in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
      1) Tests on borrow fill material.
      2) Optimum moisture – maximum dry density curve for each type of fill material.
5. Field Quality Control Submittals:
   a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
      1) Field density testing.
      2) Tests of actual unconfined compressive strength or bearing tests of each stratum.
6. Qualifications Statements:
   a. Professional engineer.
   b. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance testing required in this Section.
   c. Field Quality Control Testing Laboratory: Names and qualifications of testing laboratory employed, and qualifications of testing laboratory's personnel that will perform field quality control testing as required under this Section.

1.6 SITE CONDITIONS

A. Subsurface Information: The Supplementary Conditions indicate information available relative to subsurface conditions at the Site. Such information and data is not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by CONTRACTOR. OWNER will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR.

B. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test borings and other

exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.

C. Existing Structures:
   1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. CONTRACTOR shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by CONTRACTOR. Immediately repair and restore existing structures and Underground Facilities damaged by CONTRACTOR without additional cost to OWNER.
   2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
   3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, OWNER will assist CONTRACTOR with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
   4. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Select Fill:
   1. This material shall consist of soil material with a liquid limit (LL) less than or equal to 40, a plasticity index (PI) between 5 and 15, with 25 to 55 percent passing the No. 200 mesh sieve, greater than 80 percent passing the No. 4 mesh sieve, and 100 percent passing a 3/4-inch square mesh sieve. Particles with sizes greater than 1-1/2 inches in any dimension shall not be allowed. The material shall be free of organic or other deleterious materials.
   2. Select material shall be compatible with granular embedment as defined by the following filtration criteria:
      a. Ratio of D15 of the granular embedment material and the D85 of the select material shall be less than or equal to 4.
      b. Ratio of D50 of the granular embedment material and the D50 of the select material shall be less than or equal to 25.

B. General Fill:
   1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
   2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
   3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
   4. When On-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain ENGINEER's approval of the material proposed for use.

C. Subbase Material:
   1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand, complying with the gradation requirements below. Crushed slag is unacceptable.

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
2-inch	100
1-inch	70 to 100
3/4-inch	50 to 90
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 15

D. Course Gravel: Where coarse gravel is required for water Drainage Fill, restoration of trench foundation, or other uses, it shall be crushed stone or washed gravel and in compliance with ASTM C33 for Coarse Concrete Aggregate. Crushed concrete will not be allowed for coarse gravel. Gradation shall be ASTM C33 No. 57, No. 67, or as follows:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1-inch	95 to 100
3/4-inch	55 to 85
1/2-inch	25 to 50
No. 4	0 to 5

E. Pipe Embedment Material for Steel Pipe shall be granular cohesionless material meeting the following requirements:
   1. Crushed Stone of angular sound, durable stone material graded between the prescribed limits:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1/2-inch	100
3/8-inch	85 to 100
No. 4	10 to 30

No. 8	0 to 10
No. 16	0 to 5

Crushed stone embedment shall not contain more than 1 percent by weight of organic matter, loam, or clays, or more than 5 percent by weight of any one or combination of slate, shale, schist, or soft particles of sandstone. The percent of wear shall not exceed 40 percent when tested in accordance with ASTM C131.

2. Sand, where required, shall consist of natural or manufactured granular material and shall contain no organic material. Sand shall be non-plastic, when tested in accordance with ASTM D4318 and graded between the prescribed limits:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1/2-inch	100
3/8-inch	85 to 100
No. 4	50 to 100
No. 16	30 to 80
No. 100	0 to 10
No. 200	0 to 5

F. Pipe Embedment Material for Concrete and Ductile Iron Pipe shall be granular embedment material:

1. North Central Texas Council of Governments (NCTCOG) Item 504.2.2.1, Standard Crushed Stone – Aggregate Grade 4 in accordance with the Standard Specifications for Public Works Construction.

NCTCOG Item 504.2.2.1 Crushed Stone Embedment Standard Crushed Stone - Grade 4	
Sieve Sizes (Square Openings)	**Percentage by Weight Passing Sieve**
1-1/2-inch	100
1-inch	95 to 100
1/2-inch	60 to 25
No. 4	0 to 10
No. 8	0 to 5

2. Crushed stone embedment containing less than 1 percent by weight of organic matter, loam, or clays, and less than 5 percent by weight of any one or combination of slate, shale, schist, or soft particles of sandstone. When tested in accordance with ASTM C131, he material's percent of wear shall not exceed 40 and consist of angular sound, durable stone material graded between the prescribed limits:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
2-inch	100
1-1/2-inch	95 to 100

3/4-inch	35 to 70
3/8-inch	10 to 30
No. 4	0 to 5

3. Sand material, where required, shall consist material meeting the requirements in Paragraph E. 2. of this Section.

G. Mudmat:
   1. Mudmat shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

H. Controlled Low Strength Material (CLSM):
   1. CLSM shall be self-leveling and self-compacting cementitious material.
      a. Cement: Type I or Type II portland cement complying with ASTM C150/C150M.
      b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.
      c. Water: Clean, potable.
      d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
      e. Fine Aggregates: ASTM C33/C33M.
   2. CLSM Mix:
      a. Minimum compressive strength at 28 days: 150 PSI
      b. Maximum compressive strength at 28 days: 1800 PSI
      c. Slump: 6-9 inches
      d. Rapid early set with an initial strength capable of bearing construction traffic within 4 hours of placement
      e. Minimum density: 36 PCF

I. Granular Backfill:
   1. Material shall be recycled crushed concrete which meets TXDOT Item 247, Grade 1, Type D gradation.

2.2 SOURCE QUALITY CONTROL

A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the 'Quality Assurance" Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER is aware of conditions that may be detrimental

to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS

A. General:
   1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. CONTRACTOR shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. CONTRACTOR shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.

3.3 PREPARATION

A. Site Preparation:
   1. Site preparation shall be in accordance with Section 31 11 00, Clearing and Grubbing.
   2. Burning is not allowed at the Site.

B. Use of Explosives:
   1. Use of explosives is not allowed.

C. Dust Control:
   1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to ENGINEER’s acceptance and approval of authorities having jurisdiction.

D. Maintenance and Protection of Traffic:
   1. Keep all streets and traffic ways open for passage of traffic and pedestrians during the Project, unless otherwise approved by owner of the street, traffic way, or right-of-way, as applicable. Construction traffic shall access the Site only via entrance(s) indicated in Section 01 55 13, Access Roads and Parking Areas.
   2. When required to cross, obstruct, or temporarily close a street or traffic way, provide and maintain suitable bridges, detours, and other acceptable temporary expedients to accommodate traffic. Closings of street or traffic way shall be for shortest time practical, and passage shall be restored immediately after completion of fill and temporary paving or bridging.
   3. Give required advance notice to fire department, police department, and other emergency services as applicable of proposed construction operations.

4. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 7 days prior to construction that will affect the property.
5. Hydrants, valves, fire alarm boxes, postal boxes and delivery service boxes, and other facilities that may require access during construction shall be kept accessible for use.
6. Provide temporary signage, signals, barricades, flares, lights and other equipment, service, and personnel required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions, as applicable.

3.4 DEWATERING

A. Dewatering – General:
1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the structure to be built therein is acceptable to ENGINEER and backfilling operations are completed and acceptable to ENGINEER.
2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
4. CONTRACTOR shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
5. Remove water from excavations as fast as water collects.

B. Temporary Dewatering System:
1. CONTRACTOR shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and Underground Facilities.

3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations two feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24 hours per day, seven days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining ENGINEER's acceptance for such discontinuation.
6. If, in ENGINEER's opinion, the water levels are not being lowered or maintained as required, provide additional or alternate temporary dewatering devices as necessary, at no additional cost to OWNER.
7. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
8. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain ENGINEER's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.
9. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
10. Before discontinuing dewatering operations or permanently allowing rise of groundwater level, prepare computations to demonstrate that structures affected by the water level rise are protected by fill or other means to sustain uplift. Use a safety factor of 1.3 when preparing such calculations.

C. Disposal of Water Removed by Dewatering System:
1. CONTRACTOR's dewatering system shall discharge to a suitable location acceptable to OWNER, in accordance with Laws and Regulations. Acceptable locations include:
   a. Lagoon C.
   b. Lagoon Decant Return Water Line.
2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
4. Dispose of water in manner that causes no inconvenience to OWNER, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.

B. Excavation Protection:
   1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
   2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   4. Provide and maintain excavation protection system(s) in accordance with submittals accepted by ENGINEER and required under Paragraph 1.5.B of this Section.

C. Maintain excavations in dry condition in accordance with “Dewatering” Article in Part 3 of this Section.

D. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.

E. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill material, as directed by ENGINEER, at CONTRACTOR’s expense.

F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

G. Subgrades – General:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with course gravel material specified in Paragraph 2.1 G of this Section. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in ENGINEER’s opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR’s control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR’s expense.

H. Proofrolling Subgrades:
   1. Prior to placing fill or constructing pavements or slabs, proofroll the subgrade surface with sufficient proofrolling apparatus. Before starting proofrolling, submit

to and obtain acceptance from ENGINEER of proofrolling apparatus and procedure to be used.

2. Proofrolling operations shall be made in the presence of ENGINEER. Notify ENGINEER at least 24 hours in advance of start of proofrolling operations.
3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by ENGINEER. Unsuitable materials shall be undercut to the depth directed by ENGINEER and replaced with select fill material. Other suitable stabilization methods may be directed by ENGINEER.

I. Pipe Trench Preparation:
   1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
   2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
      a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
      b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
      c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
      d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
      e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
   3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
   4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.
   5. Bell Holes Required: Bell holes of at least 24 inches in dimension shall be dug in trenches at each joint of pipe to permit the jointing to be made properly, welding or other jointing activities to occur, heat shrink sleeves to be applied and the work visually inspected. The pipe will rest on the full length of the barrel outside the area of the bell hole. Bell hole shall be 24 inches perpendicular and 24 inches parallel to the pipe. Pipe with field-applied exterior mortar coatings shall have the joints excavated to a sufficient depth to allow proper cleaning, application, testing, and inspection of field applied coating system. Provide a sloped transition area to avoid abrupt changes in excavated trench bottom.

J. Excavated Materials to be Used as Fill:
   1. Stockpile excavated materials that are acceptable for use as fill.
   2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
   3. Place, grade, and shape stockpiles for proper drainage.
   4. Locate and retain soil materials away from edge of excavations.

5. Dispose of excess soil material and waste materials as specified in this Section.
6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION

A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR's expense.

3.7 EROSION AND SEDIMENT CONTROLS

A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING

A. General:
   1. CONTRACTOR shall design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.
   2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the ENGINEER's approval; but CONTRACTOR is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
   3. Materials:
      a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
      b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
      c. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling where subsequent removal of sheet piling might allow lateral movement of soil under adjacent structures
   4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
   5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.

6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facility, their appearance, and adjacent construction.
8. Allowable excavation support elements and options (to be combined as required include:
    a. Sloped excavations.
    b. Interlocking sheetpiles for support and/or water cutoff.
    c. Secant pile walls for support and/or water cutoff.
    d. Soil bentonite walls for water cutoff.
    e. Diaphragm walls for support and/or water cutoff.
    f. Well systems for water cutoff and relief of pressures.

B. Sheeting Left in Place:
1. Materials: Steel sheeting shown or indicated to be left in place shall consist of rolled sections of continuous interlocking type. Steel sheeting material designated to be left in place shall be new. Type and design of the sheeting and bracing shall comply with the above requirements for steel work for all sheeting and bracing.
2. Installation:
    a. Steel sheeting to be left in place shall be driven straight to lines and grades as shown, indicated, or directed. Piles shall penetrate into firm materials with secure interlocking throughout pile's entire length. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
    b. Type of guide structure used and method of driving steel sheeting to be left in place shall be determined by CONTRACTOR's professional engineer. Jetting is not allowed.
3. Cut off at elevations shown, indicated, or directed by ENGINEER sheeting left in place and remove cut off pilings from the Site.
4. Clean wales, braces, and all other items to be embedded in the permanent structure, and ensure that concrete surrounding the embedded element is sound and free of air pockets and harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and welding of steel diaphragm waterstops perpendicular to the centerline of brace ends that are to be embedded.
5. Subsequent to removing the inside face forms, and when removal of bracing is allowed, cut back steel at least two inches inside the wall face and patch opening with concrete repair mortar in accordance with Section 03 30 00, Cast-in-Place Concrete. Concrete shall be thoroughly worked beneath wales and braces, around stiffeners, and at other place where voids may be formed.
6. Portions of sheeting or soldier piles and breast boards that are in contact with structure foundation concrete shall be left in place, together with wales and bracing members that are cast into foundation or superstructure concrete.

C. Removal of Sheeting and Bracing:

1. Remove sheeting and bracing from excavations, unless otherwise directed by ENGINEER in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
    a. Concrete has cured for not less than seven days.
    b. Wall and floor framing, up to and including grade level floors, is in place.

D. Settlement Monitoring.
1. Performance of excavation support systems shall be monitored for both horizontal and vertical deflections.
2. If excessive settlement or deflections of supports or slopes occur that exceed those values predicted by the Contractor's excavation support designer, modifications to the excavation and support approach will be required. Revised shop drawings and calculations shall be submitted to the ENGINEER. Changes to excavation sequence and support shall be implemented as may be necessary at no additional cost.

3.9 TRENCH SHIELDS

A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

B. When using a shield for installing piping:
1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.

C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.

D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
   1. ENGINEER's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
   2. Inspection, testing, approval, and recording of locations of Underground Facilities.
   3. Removal of concrete formwork.
   4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
   7. Field testing of tanks, Underground Facilities including piping and conduits, and water-retaining structures.
   8. Placing of settlement plates.

C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.

D. Placement – General:
   1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
   2. Fill areas shall be undercut and proof-rolled as directed by ENGINEER.
   3. Place fill materials at moisture content and density as specified in Table 31 23 05-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.
   4. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 2,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.

5. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
6. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
7. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to OWNER, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
8. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:
1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 30 00, Cast-in-Place Concrete.
2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:
1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:
1. Place pipe bedding material in pipe trenches in horizontal layers, and thoroughly compact each layer before the next layer is placed.

2. Piping Installed in Fills Above Pre-Construction Grade:
    a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
3. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
4. Pipe Bedding: Pipe bettering material shall be as follows:
    a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
    b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
5. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
    a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
    b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.
    c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.
    d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:
1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:
   1. Provide subbase material where shown to the limits shown or indicated.
   2. Place subbase material in compacted lifts not exceeding depth of six inches each.

J. Drainage Fill Placement:
   1. Provide drainage fill material where shown to the limits shown or indicated.
   2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Compaction Density Requirements:
   1. Compaction required for all types of fills shall be in accordance with Table 31 23 05-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.

TABLE 31 23 05-A
REQUIRED MINIMUM DENSITY

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than five feet below final grade	100	8
Less than five feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Pipe Initial Backfill (Pipe Zone)	Note 1	8
Pipe Final Backfill (Above Pipe Zone)	Note 2	8
Pipe Bedding	Uncompacted	Note 3
Pipe Trench Foundation Material (Note 4)		
Below structures or pavement	100	8
All other locations	95	6
Drainage Fill	N/A	6
Granular Fill	95	8

Notes:

[1] Compaction as specified in the Drawing (Trench Details)

[2] Compaction as specified in the Drawing (Trench Details) or for General Fill in this Section whichever is higher.

[3] Depth as specified in the Drawings (Trench Details).

[4] Foundation material is defined as the area below the level of uncompacted bedding where removal and recompacting of a soft bottom condition in undisturbed site soil is required or placement of compacted fill below the pipe required by pipe and final grading.

2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus three percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 05-A of this Section.
4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform

additional compaction Work at no additional cost to OWNER until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 05-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

A. General:
   1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
   2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
   1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
   2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
   3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten-foot straight edge.

D. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Controlled Low Strength Materials Placement:
   1. Discharge CLSM from the mixer by reasonable means into the space to be filled.

2. Bring the fill material uniformly up to the fill line shown or indicated in the Contract Documents.
3. Placement of fill over the CLSM may proceed after a curing period of not less than three days.

3.13 PAVEMENT SUBBASE COURSE

A. General:
   1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by ENGINEER.

B. Grade Control:
   1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:
   1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during
   2. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
      a. Compaction with roller shall begin at the sides of the area to be paved and continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
      b. After compaction of top lift of pavement subbase, provide and uniformly spread pipe bedding material and screenings compacted, on the surface, and sweep using gang-dragged broom, followed by compaction.
      c. After rolling, check for grade with a line not less than 40 feet in length; depression over 1/2-inch deep shall be filled to satisfaction of ENGINEER.
   3. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
   4. Do not install pavement subbase in excess of 500 feet in length without compacting to prevent softening of the subgrade.
   5. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material and replace with clean, compacted subbase material.
   6. Lime sub-base for concrete and gravel paving shall be performed in accordance with North Central Texas Council of Governments (NCTCOG) Standard Specification for Public Works Construction Item 301.2 LIME TREATMENT and other NCTCOG Items referenced therein unless modified by this Paragraph:
      a. Proof rolling shall be performed with a loaded tandem-axle dump truck, scraper, or other heavy, rubber-tired vehicle weighing at least 25 tons to locate any zones that are soft or

unstable. The proof rolling shall consist of 4 passes in mutually perpendicular passes over a given area. The CONTRACTOR shall remove and replace areas of the subgrade where rutting or pumping occurs during proof rolling with on-site soils. Accomplish any required cut and fill in accordance with the requirements of this Section.

b. Subgrade soils beneath concrete or gravel pavement shall be lime stabilized and compacted to a minimum of 98 percent of the material's Standard Proctor dry density (ASTM D 698).

c. Provide 8% (minimum) hydrated lime by dry soil weight of subgrade soils, 48-pounds per square yard for an 8-inch thick stabilized layer or 37-pounds per square yard for a 6-inch stabilized layer as noted on the drawings.

d. The CONTRACTOR shall verify the required lime percentage during construction as required by NCTCOG Item 301.2.1.3 at the CONTRACTOR's expense

e. pH of the lime/soil mixture shall be 12.4 or greater.

D. Shoulders:
1. Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each lift of subbase material.
2. Compact and roll not less than 12-inch width of shoulder simultaneously with compacting and rolling of each lift of subbase material.

3.14 DISPOSAL OF EXCAVATED MATERIALS

A. General:
1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.15 TEMPORARY BARRIERS

A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.

B. Minimum Material Requirements for Temporary Barriers:
1. Temporary barrier shall not be less snow fence-type fencing, four feet high.
2. Fence shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4-inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
3. Posts:
a. Posts shall be steel, either "U"-, "Y"-, "T"-shaped, or channel section.

b. Posts shall have a nominal weight of not less than 1/3-pound per linear foot, exclusive of the anchor.
c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting or clamping.
d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.
e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

3.16 FIELD QUALITY CONTROL

A. Site Tests: OWNER shall employ a testing laboratory to perform field quality control testing.
   1. Testing Laboratory Scope:
      a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
      b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
      c. Report results of each test to ENGINEER and CONTRACTOR.
   2. Required Material Tests:
      a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
   3. Authority and Duties of Testing Laboratory:
      a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
      b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
   4. Responsibilities and Duties of CONTRACTOR:
      a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.
      b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
      c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
      d. CONTRACTOR shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
         1) 200 linear feet of trench fill.
         2) 10 cubic yards of select fill.
         3) 100 cubic yards of general fill.
         4) 50 cubic yards of subbase material.

5. Testing laboratory shall perform field density tests at a minimum of one per 2,500 square feet and one test per 100 linear feet in areas requiring hand tamping.
6. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
    a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
        1) In Open Fields: Two locations every 1,000 linear feet.
        2 Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
        3) Crossing Paved Roads: Two locations along each crossing.
        4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
    b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
    c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
    d. For General Fill: One per 1,000 square feet on every compacted lift.
    e. Subbase Material: One per 1,000 square feet on every compacted lift.
7. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.
8. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

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31 23 16.13 TRENCHING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of Underground Facilities and related construction required to complete the Work.
   2. Preparation of subgrade is included under this Section.
   3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Related Sections:
   1. Section 33 05 05, Buried Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/AISC 360, Specification for Structural Steel for Buildings.
   2. ASTM C33/C33M, Specification for Concrete Aggregates.
   3. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
   4. ASTM C150/C150M, Specification for Portland Cement.
   5. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   6. ASTM D422, Test Method for Particle-Size Analysis of Soils.
   7. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).
   8. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   9. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   10. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   11. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   12. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   13. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   14. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

15. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
16. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
17. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
18. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
      b. Responsibilities include but are not necessarily limited to:
         1) Reviewing system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
         3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
         4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
         5) Certifying that:
            a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
            b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.
   2. CONTRACTOR's Testing Laboratory:
      a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
      b. Do not employ the same laboratory hired by OWNER for field quality control testing under the field quality control Article of this Section.
      c. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
      d. Testing laboratory shall be experienced in the types of testing required.

e. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Quality Assurance Testing:
   1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
   2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
   3. CONTRACTOR's Testing Laboratory Scope:
      a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
      b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
      c. Design controlled low-strength material (CLSM) mixes in accordance with requirements of CLSM Article in Part 2 of this Section. Perform concrete materials evaluation tests and testing of CLSM mixes.
      d. Submit to ENGINEER and CONTRACTOR written report results of each test.
   4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
      a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
      b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
      c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
      d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
      e. CLSM Mix: Verify CLSM mix design by laboratory trial batch, unless indicated otherwise. Perform the following testing on each concrete mix trial batch:
         1) Aggregate gradation.
         2) Flowability, in accordance with ASTM D6103.
         3) Air content, in accordance with ASTM D6023.
         4) Unconfined compressive strength of CLSM mixes at 90 days, in accordance with ASTM D4832.
         5) Submit for each concrete mix trial batch the following information:
            a) Project identification name and number (if applicable).
            b) Date of test report.
            c) Complete identification of aggregate source of supply.

d) Tests of aggregates for compliance with the Contract Documents.
e) Brand, type, and composition of cementitious materials.
f) Brand, type, and quantity of each admixture.
g) Quantity of water used in trial mixes.
h) Proportions of each material per cubic yard.
i) Gross weight and yield per cubic yard of trial mixtures.
j) Measured flowability.
k) Measured air content.
l) Unconfined compressive strength.

C. Regulatory Requirements:
1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. List of CLSM materials and mix designs proposed for use. Include results of quality assurance testing performed to qualify the materials and to establish the mix designs.
b. Laboratory Trial Batch Reports: Submit laboratory quality assurance test reports for materials and mix design tests.
c. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.
2. Product Data:
a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures to be used in CLSM mixes.
3. Samples:
a. Submit Sample of each aggregate and soil material required under this Section. Deliver Samples to ENGINEER. Samples shall be of sufficient size to demonstrate the array of gradation and material types expected in the Work.

B. Informational Submittals: Submit the following:
1. Procedure Submittals:
a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.
2) Excavation method(s) and additional items to be included in the Work, as listed in Paragraph 1.5.B.2.a of this Section.

3) Copies of “manufacturer's data” or other tabulated data if protective system(s) are designed on the basis of such data.
4) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.

b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.

2. Excavation Support Plan and Related Information Prepared by CONTRACTOR’s Professional Engineer:
   a. CONTRACTOR and CONTRACTOR’s professional engineer shall prepare the following for submittal:
      1) Sheeting and bracing, or other protective system(s) required.
      2) Dewatering system.
      3) Cofferdams.
      4) Underpinning.
   b. Drawings and calculations shall be prepared by professional engineer qualified in the specialty involved. ENGINEER’s review and acceptance of submittal does not imply approval by ENGINEER of the associated Work. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining the system(s) required to satisfactorily perform all necessary sheeting, bracing, protection, underpinning, and dewatering.
3. Delivery Tickets:
   a. Copies of delivery tickets for each load of CLSM material delivered to or mixed at the Site. Each delivery ticket shall contain information in accordance with ASTM C94/C94M along with project and contract name and number, date, mix type, mix time, quantity and amount of water introduced.
4. Quality Assurance Test Results Submittals:
   a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
      1) Tests on borrow fill material.
      2) Optimum moisture – maximum dry density curve for each type of fill material.
5. Field Quality Control Submittals:
   a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
      1) Field density testing.
      2) Tests of actual unconfined compressive strength or bearing tests of each stratum.
6. Qualifications Statements:
   a. Professional engineer.
   b. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory’s

personnel that will perform quality assurance testing required in this Section.

c. Field Quality Control Testing Laboratory: Names and qualifications of testing laboratory employed, and qualifications of testing laboratory's personnel that will perform field quality control testing as required under this Section.

1.6 SITE CONDITIONS

A. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test borings and other exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.

C. Existing Structures:

1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. CONTRACTOR shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by CONTRACTOR. Immediately repair and restore existing structures and Underground Facilities damaged by CONTRACTOR without additional cost to OWNER.
2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
3. Coordinate with utility owners for shut-off of services in active piping and conduits. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
5. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Select Fill:

1. Material shall be well-graded, crushed aggregate, free of organic material. Material shall in accordance with ASTM D6913.

B. General Fill:

1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain ENGINEER's approval of the material proposed for use.

C. Subbase Material:

1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable. Material shall be in accordance with ASTM D1241.

D. Drainage Fill:
1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

E. Pipe Bedding Material:
1. Aggregate material shall be crushed stone and gravel, free of: rock or gravel larger than 1/2-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter. Material shall be Item 432 in accordance with Texas Department of Transportation.
2. Sand material, where required, shall consist of natural or manufactured granular material and shall contain no organic material. Sand shall be non-plastic, when tested in accordance with ASTM D4318, 100 percent shall pass a 1/2-inch screen and not more than five percent shall pass a No. 200 screen.

F. Controlled Low Strength Material (CLSM):
1. CLSM shall be self-leveling and self-compacting cementitious material.
    a. Cement: Type I or Type II portland cement complying with ASTM C150/C150M.
    b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.
    c. Water: Clean, potable.
    d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
    e. Fine Aggregates: ASTM C33/C33M.
2. CLSM Mix:
    a. Cement Content: 50 pounds per cubic yard.
    b. Fly Ash Mineral Admixture: 250 pounds per cubic yard.
    c. Fine Aggregate Content: 2910 pounds per cubic yard.

d. Water Content: 500 pounds per cubic yard.
e. Admixtures shall comply with manufacturer's recommendations for use with CLSM.
f. Unconfined compressive strength shall be greater than 150 psi after 28 days.
g. Adjustment of Mixes.
    1) Mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
    2) Submit for ENGINEER's approval laboratory test data for adjusted mix designs, including compressive strength test results.
    3) Implement adjusted mix designs only after ENGINEER's approval.
    4) Adjustments to mix designs shall not result in additional costs to OWNER.

2.2 SOURCE QUALITY CONTROL

A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the 'Quality Assurance" Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS

A. General:
    1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. CONTRACTOR shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. CONTRACTOR shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.
B. Payment for Test Pits:
    1. All payment for test pits shown or indicated in the Contract Documents will be part of the lump sum Contract Price.
    2. Payment for test pits required by ENGINEER and not shown or indicated in the Contract Documents will be paid as Unit Price Work.

3. Separate payment will not be made for test pits made by CONTRACTOR for CONTRACTOR's own use.

3.3 PREPARATION

A. Site Preparation:
   1. Site preparation shall be in accordance with Section 31 11 00, Clearing and Grubbing.
   2. Burning is not allowed at the Site.

B. Use of Explosives:
   1. Use of explosives is not allowed.

C. Dust Control:
   1. Dust control shall be in accordance with Section 01 41 27 Earthmoving Permit and Dust Control

3.4 DEWATERING

A. Dewatering – General:
   1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the Underground Facilities to be built therein area acceptable to ENGINEER and backfilling operations are completed and acceptable to ENGINEER.
   2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
   3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
   4. CONTRACTOR shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
   5. Remove water from excavations as fast as water collects.

B. Temporary Dewatering System:
   1. CONTRACTOR shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level at a

minimum of three (3) feet below the base of each excavation during all stages of construction operations.

2. Design and operate dewatering system to avoid settlement and damage to existing structures and Underground Facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations two feet below lowest subgrade excavation until the structure or Underground Facility, as applicable, has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24 hours per day, seven days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining ENGINEER's acceptance for such discontinuation.
6. If, in ENGINEER's opinion, the water levels are not being lowered or maintained as required, provide additional or alternate temporary dewatering devices as necessary, at no additional cost to OWNER.
7. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
8. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain ENGINEER's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads.
9. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
10. Before discontinuing dewatering operations or permanently allowing rise of groundwater level, prepare computations to demonstrate that structures affected by the water level rise are protected by fill or other means to sustain uplift. Use a safety factor of 1.25 when preparing such calculations.

C. Disposal of Water Removed by Dewatering System:

1. CONTRACTOR's dewatering system shall discharge to suitable location acceptable to OWNER and owners of other properties potentially affected by water discharge, including owners adjacent to and downstream of dewatering system discharge. Operation dewatering system and disposal of water shall be in accordance with Laws and Regulations.
2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
4. Dispose of water in manner that causes no inconvenience to OWNER, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.

B. Excavation Protection:
   1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
   2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   4. Provide and maintain excavation protection system(s) in accordance with submittals accepted by ENGINEER and required under Paragraph 1.5.B of this Section.

C. Maintain excavations in dry condition in accordance with “Dewatering” Article in Part 3 of this Section.

D. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing. Elevations of piping, conduit, and similar other Underground Facilities shall be as shown or indicated on the Contract Documents.

E. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill material, as directed by ENGINEER, at CONTRACTOR’s expense.

F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

G. Subgrades – General:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with select fill. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in ENGINEER’s opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR’s control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR’s expense.

H. Pipe Trench Preparation:

1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
    a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
    b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
    c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
    d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
    e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.

I. Excavated Materials to be Used as Fill:
1. Stockpile excavated materials that are acceptable for use as fill.
2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
3. Place, grade, and shape stockpiles for proper drainage.
4. Locate and retain soil materials away from edge of excavations.
5. Dispose of excess soil material and waste materials as specified in this Section.
6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION

A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR’s expense.

3.7 EROSION AND SEDIMENT CONTROLS

A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING

A. General:
   1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.
   2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the ENGINEER's approval; but CONTRACTOR is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
   3. Materials:
      a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
      b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
      c. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling where subsequent removal of sheet piling might allow lateral movement of soil under adjacent structures
   4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
   5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.
   6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
   7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facilities, their appearance, and adjacent construction.
   8. When sheeting or shoring is to remain in place, cut off tops, as required, and leave permanently in place.

B. Sheeting Left in Place:
   1. Materials: Steel sheeting shown or indicated to be left in place shall consist of rolled sections of continuous interlocking type. Steel sheeting material designated to be left in place shall be new. Type and design of the sheeting and bracing shall comply with the above requirements for steel work for all sheeting and bracing.
   2. Installation:
      a. Steel sheeting to be left in place shall be driven straight to lines and grades as shown, indicated, or directed. Piles shall penetrate into firm materials with secure interlocking throughout pile's entire length. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
      b. Type of guide structure used and method of driving steel sheeting to be left in place shall be determined by CONTRACTOR's professional engineer. Jetting is not allowed.

3. Cut off at elevations shown, indicated, or directed by ENGINEER sheeting left in place and remove cut off pilings from the Site.
4. Portions of sheeting or soldier piles and breast boards that are in contact with concrete shall be left in place.

C. Removal of Sheeting and Bracing:
1. Remove sheeting and bracing from excavations, unless otherwise directed by ENGINEER in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until concrete has cured for not less than seven days.

3.9 TRENCH SHIELDS

A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

B. When using a shield for installing piping:
1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.

C. When using a shield for installing structures, including structures that are Underground Facilities, bottom of the shield shall not extend below the top of the bedding for the structures.

D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or other Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
1. ENGINEER's authorization after observation of construction below finish grade.
2. Inspection, testing, approval, and recording of locations of Underground Facilities.
3. Removal of formwork.
4. Removal of shoring and bracing, and filling of voids with satisfactory materials.

5. Removal of trash and debris.
6. Field testing of Underground Facilities including piping and conduits, in accordance with Section 33 05 05, Buried Piping Installation, when nature of the test requires observation of pipe exterior during testing.

C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.

D. Placement – General:
1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
2. Place fill materials at moisture content and density as specified in this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.
3. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and other Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.
4. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
5. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning

compaction equipment, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to OWNER, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.

7. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:
   1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 30 00, Cast-in-Place Concrete.
   2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls.
   3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
   4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Pipe Trenches:
   1. Piping Installed in Fills Above Pre-construction Grade:
      a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
   2. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing.
   3. Pipe Bedding: Pipe bettering material shall be as follows:
      a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
      b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
   4. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
      a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
      b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain

alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.

c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.

d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

G. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

H. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of six inches each.

I. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

J. Compaction Density Requirements:

1. Minimum density for fill materials shall be 100 percent of maximum density obtained in the laboratory in accordance with ASTM D698. Compaction of fill materials less than five feet below final grade, behind concrete walls, and pipe bedding materials when not located below structures or pavement shall be 95 percent of maximum density.
2. Place fill in trenches below piping, foundations, or paved areas in horizontal uncompacted layers not greater than eight inches deep, and thoroughly compact each layer before next layer is placed. In other pipe trenches, horizontal uncompacted layers shall be not greater than six inches deep.
3. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus three percent.
4. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.

5. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
6. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to OWNER until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

K. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with "Compaction Density Requirements" of this Article and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

A. General:
1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
3. Blend grading over trench to elevations shown or indicated; where elevations are not shown or indicated, blend finished grade with existing grade on each side of trench.

B. Finish surfaces free of irregular surface changes, and shall comply with the following:
1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

D. Compaction:
1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Controlled Low Strength Materials Placement:

1. Discharge CLSM from the mixer by reasonable means into the space to be filled.
2. Bring the fill material uniformly up to the fill line shown or indicated in the Contract Documents; if not shown or indicated, bring the fill material uniformly to the desired level.
3. Placement of fill over the CLSM may proceed after a curing period of not less than three days.

3.13 PAVEMENT SUBBASE COURSE

A. General:
1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section.
3. Fill trenches over which pavement will be placed with select fill.
4. Fill trenches adjacent to paved areas with select fill to an elevation equal to the elevation where a line projecting from outer edge of paved surface (including shoulders) at an angle of 45 degrees from horizontal intersects the centerline of trench. Above this elevation, fill trench with suitable general fill material.

B. Grade Control:
1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:
1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
2. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.

3.14 DISPOSAL OF EXCAVATED MATERIALS

A. General:
1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.15 TEMPORARY BARRIERS

A. General:
1. Provide temporary barrier surrounding excavations and excavation work areas for protection of persons and property. Temporary barriers supplement the requirements of Section 01 55 26, Maintenance and Protection of Traffic.

2. Provide temporary barriers where shown or indicated, and where necessary to protect persons and property. At minimum, provide temporary barriers for all excavations that remain open overnight or longer.

B. Temporary Snow Fence-type Barriers:
   1. Unless shown or indicated otherwise, temporary barrier shall be not less snow fence-type fencing, four feet high.
   2. During non-working hours, completely enclose all sides of excavation with temporary barrier.
   3. Fencing shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4-inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
   4. Supports: Adequately support barrier to protect persons and property. Supports shall engage a substantial number of fence line wire in the proper position.
   5. Maintenance: Maintain temporary snow fence-type barriers as required. Repair or replace when damaged. Reinstall barriers where barrier installation has degraded over original temporary barrier installation.
   6. Removal: Remove the barriers from the Site when excavation is properly filled, or when directed.

C. Temporary Concrete Barriers:
   1. Where shown or indicated, provide temporary concrete barriers for trenches and excavations.
   2. Installation: Provide clean, precast concrete barriers on a stable base. Properly join and align the barriers at required locations. Provide a bond breaker when placing barrier on bituminous pavement to prevent damaging the pavement when removing the barrier. Provide delineators and warning lights in accordance with the Contract Documents and in accordance with manufacturer's recommendations.
   3. Maintenance:
      a. Maintain alignment, delineation, warning lights, and condition of the barriers as necessary.
      b. Immediately replace or repair barriers that are damaged. Such damage includes, but is not limited to, cracks or fractures that may hinder barrier performance.
   4. Removal: Remove the barriers from the Site when excavation is filled and appropriately restored, or when directed.

3.17 FIELD QUALITY CONTROL

A. Site Tests: Employ a testing laboratory to perform field quality control testing.
   1. Testing Laboratory Scope:
      a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
      b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
      c. Report results of each test to ENGINEER and CONTRACTOR.

2. Required Material Tests:
    a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
3. Authority and Duties of Testing Laboratory:
    a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
    b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
4. Responsibilities and Duties of CONTRACTOR:
    a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.
    b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
    c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
    d. CONTRACTOR shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
        1) 200 linear feet of fill in trenches, except subbase material.
        2) 10 cubic yards of select fill other than that placed in trenches.
        3) 100 cubic yards of general fill other than that placed in trenches.
        4) 50 cubic yards of subbase material.
5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
    a. Trenches for Underground Facilities:
        1) In Open Fields: Two locations every 1,000 linear feet.
        2 Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
        3) Crossing Paved Roads: Two locations along each crossing.
        4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
    b. Subbase Material: One per 1,000 square feet on every compacted lift.
6. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR.

CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

+ + END OF SECTION + +

31 63 29 DRILLED CONCRETE PIERS

PART I - GENERAL

1.01 DESCRIPTION

A. Furnish all labor and materials required to construct drilled concrete piers complete including layout, excavation of shafts, steel casings, fabrication and installation of reinforcing steel, furnishing and placing concrete, setting anchor bolts, and removal of spoil.

B. RELATED WORK

1. Section 03 20 00 - Concrete Reinforcement
2. Section 03 30 00 - Cast-In-Place Concrete

1.02 REFERENCES

A. ACI 336.1 - Standard Specification for the Construction of Drilled Piers.

1.03 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Indicate dimensioned plan layout, dowel and anchor bolt setting plans including templates, drilled pier shaft sizes, casing sizes, and top elevation, and details of reinforcing steel.
2. Concrete mix designs shall be submitted as required in 03 30 00.

B. Submittals for Information:

1. Pier Drilling Log: Report of drilled concrete pier construction including actual elevations of top and bottom of each pier, elevation of bearing stratum, penetration into bearing stratum, deviations of pier centerline and plumbness, shaft size, presence of water, use of temporary casing, placement of concrete, and time of start and finish of excavation.

1.04 QUALITY ASSURANCE

A. The laboratory and OWNER representative shall monitor all pier drilling operations. CONTRACTOR shall give a minimum two days' notice to the laboratory for services in conjunction with drilled piers.

B. Installer: Company specializing in performing the work of this Section with minimum of three projects in similar soil and rock conditions, and with similar shaft sizes, depths, and quantities.

1.05 JOB CONDITIONS

A. Site Information:

1. Information regarding site conditions is provided for the convenience of the Contractor and is not a warranty that the information represents site conditions that may be encountered. The OWNER shall not be responsible for interpretations or conclusions drawn from the information provided by the CONTRACTOR.

2. Additional borings or other exploratory work may be conducted by the CONTRACTOR at no cost to the OWNER.

B. Utilities:

1. Locate existing piping and utilities prior to the commencement of drilled concrete pier operations. Provide protection of piping and utilities during construction.

2. Do not interrupt piping and utilities serving existing facilities unless permitted in writing by the ENGINEER and OWNER. Provide temporary utility services to replace interrupted utilities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcement: Refer to Section 03 20 00.

B. Concrete: Refer to Section 03 30 00.

C. Bar Supports: Furnish spacers to maintain the required concrete cover to the sides and bottom of the excavation.

1. Shaftspacer Systems, Foundation Technologies, Inc., Tucker, Georgia.

2. "Centraligner" and "Hijacker", Pieresearch, Arlington, Texas.

D. Temporary Steel Casings: The casing shall be strong enough to withstand handling stresses and pressures of concrete and of the surrounding earth or water, and that is watertight, smooth, clean, and free of accumulations of hardened concrete.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Drill pier shafts to diameters and depths indicated.

B. Clean shaft and bottom of loose material. Maintain shafts free of water. Provide temporary steel casing to the bearing stratum to prevent caving soil and to ensure a watertight seal. Required pier penetration in the bearing strata shall be below the bottom of any casing.

C. Allow inspection of shaft prior to placement of reinforcement and concrete.

D. Place reinforcing steel in accordance with Section 03 20 00.

E. Place concrete in accordance with Section 03 30 00.

1. Concrete shall be placed within the time limit stated on the Drawings.

2. Placing equipment shall be designed for vertical placement of concrete. Use tremies where a drop of more than 10'-0" is required. Use hoppers to keep the concrete from striking the reinforcing cage and casings.
3. Provide mechanical vibration for consolidation for the upper 5'-0" of each shaft.
4. Concrete slump for piers shall be 6-inches plus or minus 1-inch.

F. Form top of shafts if cut off elevation is above ground elevation.

G. Remove excess concrete at the top of piers beyond the limits of the pier shaft diameter. Top of the shaft shall be of the same diameter as the shaft below.

H. Excavated material shall be removed and disposed off site, or shall be deposited and spread on-site at locations as directed by the OWNER.

I. OWNER shall employ the services of a testing lab to ensure that pier installation is in accordance with the contract documents.

3.02 TOLERANCES

A. Maximum Variation From Vertical: One percent of the length.

B. Maximum Variation From Design Top Elevation: Plus 1 inch to minus 3 inches.

C. Maximum Out-of-Position: One twenty-fourth of the shaft diameter or 3 inches, whichever is less.

END OF SECTION

32 13 13 CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete pavement, curbs, gutters, and sidewalks.
   2. The Work required under this Section includes conventionally-formed or machine-formed concrete pavement, curb, gutter and sidewalk.
   3. Width, thickness, geometry, and extent of paving shall be as shown or indicated on the Drawings.

B. Related Sections:
   1. Section 01 14 16, Coordination with Owner's Operations
   2. Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor
   3. Section 03 11 00, Concrete Forming.
   4. Section 03 15 00, Concrete Accessories.
   5. Section 03 20 00, Concrete Reinforcing.
   6. Section 03 30 00, Cast-In-Place Concrete.
   7. Section 07 92 00, Joint Sealants.
   6. Section 32 23 05, Excavation and Fill.

1.2 REFERENCES

A. ACI 301 - Specifications for Structural Concrete for Buildings.
B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
C. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
D. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
E. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
F. ASTM C33 - Concrete Aggregates.
G. ASTM C94 - Ready Mix Concrete.
H. ASTM C150 - Portland Cement.
I. ASTM C260 - Air-Entraining Admixtures for Concrete.
J. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
K. ASTM C494 - Chemical Admixtures for Concrete.
L. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
M. "Public Works Construction Standards, North Central Texas", latest edition as published by the North Central Texas Council of Governments (COG Item 303).

1.3 QUALITY ASSURANCE

A. Concrete provided under this section shall meet the Quality Assurance specifications set forth in Section 03 30 00, Cast-in-Place Concrete.

B. Qualifications:
   1. Installer:
   a. Installer shall have not less than two years experience installing concrete paving similar to that required for the Work.
   b. When required by ENGINEER, submit record of experience documenting not less than three successful, completed projects. For each project, submit name the following information: project name, location of project, approximate quantity of pavement, concrete curb, gutter, and sidewalk constructed by installer, contract price of pavement, concrete curb, gutter, and sidewalk construction, and name and contact information for project owner and the project's construction-phase engineer.

C. Regulatory Requirements:
   1. Reference Specifications and Details:
      a. Comply with applicable requirements of COG Item 303.

D. Obtain cementitious materials from same source throughout.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
   a. Submit concrete mix design when mix design is different from that submitted under Division 03 Sections on concrete. Submit in accordance with Division 03 Sections on concrete.
   b. Proposed reinforcing materials.
   2. Product Data:
   a. Concrete Materials: Submit Supplier's technical information for materials proposed for use, when concrete materials are different from those submitted under Division 03 Sections on concrete.
   b. Reinforcing Steel: Submit fabricator's technical information, including catalog information and specifications, for materials proposed for use, sufficient for ENGINEER to verify compliance with the Contract Documents.
   c. Expansion Joint Filler: Submit Supplier's technical information, including manufacturer's product data, brochure, and specifications, for materials proposed for use, when materials are different from those submitted under Division 03 Sections on concrete.

B. Informational Submittals: Submit the following:
   1. Certifications:
   a. Submit certifications as required in concrete Specifications Sections referred to in this Section.
   2. Site Quality Control Submittals:
      a. Concrete test results for the Work included under this Section.

3. Qualifications Statements:
   a. Installer, when requested by ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Division 03 Sections on concrete referenced in this section.

1.6 SITE CONDITIONS

A. Weather and Temperature Limitations:
   1. When temperature and environmental conditions warrant, comply with requirements for cold weather placing and hot weather placing under Division 03 Sections referenced in this Section, unless otherwise required under this Section.
   2. Temperature of aggregate base material under concrete shall be 39 degrees F or higher. Aggregate base material shall not have snow, ice, frost, or standing water on its surface at the time of concrete placing. Use of insulating materials and heating equipment may be required before concrete placing begins.
   3. Discontinue concrete placing when the air temperature falls below 39 degrees F. Do not place concrete in the rain.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Materials:
   1. Comply with applicable requirements of: Section 03 11 00, Concrete Forming; Section 03 15 00, Concrete Accessories; Section 03 20 00, Concrete Reinforcing; and Section 03 30 00, Cast-in-Place Concrete; including requirements for formwork, concrete materials, admixtures, bonding materials, curing materials, and others as required.
   2. Concrete Mix, Design, and Testing:
   a. Comply with applicable requirements of Section 03 30 00, Cast-in-Place Concrete, for concrete mix design, sampling, and testing, and quality control.
   b. Roadway paving (including monolithic curb and gutter): COG Class P1, minimum 4,000 psi compressive strength at 28 days. Where paving is placed by hand, required compressive strength shall be increased to 4,500 psi.
   c. Sidewalk / mow strip paving: COG Class A, minimum 3,000 psi compressive strength at 28 days.
   d. Design the mix to produce concrete of properties of compressive strength, slump range, and air content as specified in COG Item 303.
   e. When machine-formed equipment is used, concrete so placed shall have properties in accordance with COG Item 303, except that maximum slump shall be 2.5 inches and air content shall be two percent of design.

B. Reinforcing Materials:
   1. Provide deformed steel bars complying with Section 03 20 00, Concrete Reinforcing.

C. Expansion Joint Material:

1. Preformed Expansion Joint Filler: Comply with Section 03 15 00, Concrete Accessories, for preformed expansion joint fillers.
2. Joint Sealant: For joint sealants and accessories used on expansion joints, comply with Section 07 92 00, Joint Sealants.

D. Fly ash may be used in all classes of concrete to replace a portion of the Portland cement in a mix design. The maximum cement reduction shall not exceed 20-percent by weight per cubic-yard of concrete. Fly ash replacement shall be on a weight basis. The minimum replacement ratio shall be 1.0-pounds of fly ash per 1.0-pounds of cement replaced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine subgrade, subbase, and conditions under which the Work is will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are been corrected.

B. Subgrade:
1. Verify that earthwork is completed to correct line and grade.
2. Verify that subgrade is smooth, properly compacted, and free of frost and excessive moisture in accordance with Division 31 Section on excavation and fill.
3. Do not commence the Work under this Section until conditions are satisfactory.

3.2 CONSTRUCTION OF FORMS

A. Conventional Forms:
1. Set forms to line and grade. Forms shall be free from warp.
2. Install forms along full length of pavement section, curb, gutter, and sidewalk.
3. Forms shall extend to the full depth of the pavement section, curb, sidewalk, and gutter (as applicable) and be secured so no displacement occurs during concrete placing.

B. At CONTRACTOR's option, machine-formed concrete roadway, curbs, sidewalks, and gutters are acceptable.

3.3 REINFORCING

A. General:
1. Locate, place, and support reinforcing in accordance with Section 03 20 00, Concrete Reinforcing, unless otherwise shown on the Drawings.
2. Size of reinforcing shall be as shown or indicated in the Contract Documents.
3. Unless otherwise shown or indicated, locate reinforcing for sidewalks at the mid-depth point in the concrete slab.

B. When machine-formed concrete is provided, reinforcing shall be suitable for the forming/placing method, at no additional cost to OWNER. Obtain ENGINEER's approval of alternate reinforcing prior to placing concrete.

3.4 CONCRETE PLACING

A. General:
   1. Comply with Section 03 30 00, Cast-in-Place Concrete, and this Section relative to mixing and placing concrete.

B. Placing:
   1. Roadway Paving: Place concrete using methods that prevent segregation of the mix. Consolidate concrete along face of forms with an internal vibrator.
   2. Sidewalks: Place concrete in one-course, monolithic construction, for full width and depth of sidewalk.
   3. Machine-Formed:
   a. At CONTRACTOR's option, automatic paving machine may be used for installing concrete.
   b. Machine forming shall produce roadway, curbs, gutters, and sidewalks of required cross-section, lines, grades, finish, and jointing, as specified for conventionally-formed concrete.
   c. At curb cuts and driveway entrances, cut-out concrete and hand-finish the curbing to provide the required curb cut or driveway entrance, as applicable.
   d. If results do not comply with the Contract Documents, remove and replace at no additional cost to OWNER.

3.5 JOINTS

A. General:
   1. Provide expansion joints, contraction joints, and construction joints in all paving.
   2. Provide expansion, contraction, and construction joints perpendicular to formed faces paving sections.
   3. Construct transverse joints at right angles to the Work centerline and as shown.

B. Contraction Joints: Provide joints as detailed on the plans at minimum intervals indicated in the Paving Plan general notes.

C. Construction Joints: Place construction joints at locations where concrete placing operations are stopped for more than 30 minutes, except where such pours terminate at expansion joints.

D. Expansion Joints:
   1. General: Provide preformed expansion joint filler at locations indicated. When roadway, curb, gutter, or sidewalk is not poured monolithically, provide expansion joints where each abuts the other.
   2. Provide expansion joints as detailed in the drawings.
   4. Place top of expansion joint material not less than 1/2-inch or more than one-inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with sealant manufacturer's instructions and Section 07 92 00, Joint Sealants.

3.6 CONCRETE FINISHING

A. Smooth exposed surface by screeding and floating. Perform hand-screeding when conventionally-formed concrete is provided.

B. Work edges of gutter and sidewalks, back top edge of curb, and transverse joints; and round to 1/4-inch radius.

C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.7 CURING

A. General:
   1. Protect and cure finished concrete pavement in accordance with Section 03 30 00, Cast-in-Place Concrete.
   2. Cure driveways and sidewalks at driveways for not less than three days prior to opening to vehicle traffic. In colder weather, as indicated in Article 1.6 of this Section, curing period shall be not less than six days prior to opening to vehicle traffic unless other provisions to determine strength are provided and approved by ENGINEER.

3.8 REPAIR AND CLEANING

A. Repair or replace broken or defective paving as directed by ENGINEER.

B. Sweep the paving Work and wash free of stains, discolorations, dirt, and other foreign material.

3.9 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. Employ a testing laboratory to perform field quality control testing for concrete paving.
   2. Field quality control testing shall be in accordance with the specifications set forth in Section 03 30 00, Cast-in-Place Concrete.

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33 05 05 BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
      b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at 5-feet from the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
      c. Work on or affecting existing buried piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
      e. Supports, restraints, and thrust blocks.
      f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
      g. Field quality control, including testing.
      h. Cleaning and disinfecting.
      i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 40 05 34.23, Steel Process Pipe
   3. Section 40 05 19, Ductile Iron Process Pipe

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASME Boiler and Pressure Vessel Code.
   2. ASME B31.3, Process Piping.
   3. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   4. ASTM B32, Specification for Solder Metal.

5. ASTM C12, Practice for Installing Vitrified Clay Pipe Lines.
6. ASTM C425, Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
7. ASTM C828, Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
8. ASTM C924, Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Test Method.
9. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
10. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
11. ASTM D4174, Practice for Cleaning, Flushing and Purification of Petroleum Fluid Hydraulic Systems.
12. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.
13. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
14. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
15. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
16. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
17. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
18. ANSI/AWWA C603, Installation of Asbestos-Cement Pressure Pipe.
19. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
20. ANSI/AWWA C606, Grooved and Shouldered Joints.
21. ANSI/AWWA C651, Disinfecting Water Mains.
22. AWWA M9, Concrete Pressure Pipe.
23. AWWA M11, Steel Water Pipe - A Guide for Design and Installation.
24. AWWA M23, PVC Pipe - Design and Installation.
25. AWWA M41, Ductile-Iron Pipe and Fittings.
26. AWWA M45, Fiberglass Pipe Design.
27. AWWA M55, PE Pipe - Design and Installation.
28. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
29. American Concrete Pipe Association, Concrete Pipe Handbook.
30. Chlorine Institute, Inc., Piping Systems for Dry Chlorine, Pamphlet No. 6.
31. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.
   2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Laying schedules for concrete pipe and piping with restrained joints.
      b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
   2. Product Data:
      a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
   3. Testing Procedures:
      a. Submit proposed testing procedures, methods, apparatus, and sequencing a minimum of 10 days prior to conducting the test. Obtain ENGINEER's approval prior to commencing testing.
   4. Existing Utility Support Plan
      a. Submit proposed plan to support existing utilities for open cut operations. Plan shall be sign and sealed by a Professional Engineer licensed in the State of Texas.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
   2. Field Quality Control Submittals:
      a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
      b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
      c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
      d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General:
   1. For requirements applicable to the delivery, storage and handling of steel pipe refer to Section 40 05 24.23 Steel Process Pipe, Paragraph 1.5. and Section 40 05 19 Ductile Iron Process Pipe, Paragraph 1.5.

B. Delivery:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

C. Storage:
1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

D. Handling:
1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.

B. General:
1. Pipe Markings:
a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Gradation and Quality: refer to Section 31 23 05 Excavation and Fill for gradation and quality requirements for trench restoration (foundation) fill, embedment, encasement and associated miscellaneous backfill materials.

D. Polyethylene Encasement:
1. Linear Low-Density Polyethylene (LLDPE) Film for encasement of underground metallic pipe shall be supplied in tube form. LLDPE film in sheet form shall be acceptable for application to tees, crosses or other specials that cannot be encased using tube form materials.
2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

3. Material: film consisting of three fused layers of co-extruded linear low-density polyethylene film with a minimum combined total thickness of 0.008-inch (8-Mill), V-Bio® by Thrumbull Manufacturing or equal.

D. Cathodic Protection:
   1. Bonding Cables: Bonding cable and test lead wires shall be not less than No. 6 AWG, Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.
   2. Test Lead Stations: Provide test lead stations where shown and indicated in the Contract Documents. Standard connection boxes for test lead stations shall be plastic terminal boxes, 18 inches long and five-inch inside diameter, with locking cast iron lid with "CP TEST" cast into cover. Inside terminal box shall be terminal block with seven terminals. Terminal box shall be manufactured by C.P. Test Services "NM-7" or equal.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
   1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation
      b. Seton Identification Products
      c. Marking Services, Inc.
      d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
   1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE SOLUTION", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] POTABLE WATER PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation

b. Seton Identification Products
c. Marking Services, Inc.
d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. This Section includes general requirements for installation of buried pipe. Refer to the specific pipe material sections for additional requirements. In the event of conflict the requirements specified in the pipe material section shall apply.
2. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
3. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
4. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
5. Minimum cover over buried piping shall be 5 feet, unless otherwise shown or approved by ENGINEER.
6. Earthwork is specified in Section 31 23 05, Excavation and Fill.
7. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted.
8. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Manufacturer's Installation Specialist:
1. Provide services of competent installation specialist of pipe manufacturer when pipe installation commences for:
a. Steel Process pipe.
b. Ductile Iron Process Pipe
2. Retain installation specialist at the Site for the minimum period specified in Section 40 05 24.23 Steel Process Pipe and Section 40 05 19 Ductile Iron Process Pipe.

C. Separation of Sewers and Potable Water Piping:
1. Horizontal Separation:
a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
c. Exception:
1) Where it is not possible to provide minimum horizontal separation

described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:
    a. Provide minimum vertical distance of 2-feet between outside of potable water main and outside of sewer when sewer crosses over potable water main.
    b. Center a section of potable water main pipe at least 18 feet long over sewer so that sewer joints are equidistant from potable water main joints.
    c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
    d. Exceptions:
        1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 225 psi.
        2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

D. Plugs:
1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

E. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
1. Trench excavation and backfill, and bedding materials shall conform to Section 31 23 05, Excavation and Fill,as applicable.
2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 31 05 16, Aggregates for Earthwork. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal

diameter, and minimum of ten inches of granular bedding material underneath pipes four-inch nominal diameter and larger.

4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until ENGINEER approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

F. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
      a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
      b. Concrete Pipe: AWWA M9.
      c. Steel Pipe: ANSI/AWWA C206, AWWA M11.
   2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
   3. Slope piping uniformly between low points and high points. Intermediate high and low points shall be eliminated to avoid abrupt changes in elevation. No additional compensation shall be made for extra trench depth required to meet these conditions.
   4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
   5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
   6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
   7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
   8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
   9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
   10. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
   11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
   12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and

spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.

13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
16. Notify ENGINEER in advance of backfilling operations.
17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

G. Polyethylene Encasement:
   1. Provide polyethylene encasement for all buried ductile iron piping to prevent contact between pipe and surrounding bedding and embedment material.
   2. Polyethylene encasement installation of pipe shall be in accordance with ANSI/AWWA C105 Method A.
   3. ANSI/AWWA C105 Method C shall be acceptable for encasement of tees, crosses and other specials where tube form materials cannot be used.
   4. Use of ANSI/AWWA C105 Method B, or Method C except as noted in Paragraph G. 3. Above, is not acceptable.

H. Jointing Pipe:
   1. Ductile Iron Mechanical Joint Pipe:
      a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
      b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
      c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
      d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
      e. Push gland toward socket and center gland around pipe with gland lip against gasket.
      f. Insert bolts and hand-tighten nuts.
      g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.

i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.

2. Ductile Iron Push-On Joint Pipe:

a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.

b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.

c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.

d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.

e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.

f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.

3. Ductile Iron Proprietary Joints:

a. Install pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, in accordance with manufacturer's instructions.

4. Thermoplastic Pipe Joints:

a. Solvent Cement Welded Joints:

1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.

2) Use solvent cement supplied or recommended by pipe manufacturer.
3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.

b. Bell and Spigot Joints:
1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.
2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.

5. Copper Tubing Joints:
a. Soldered Joints:
1) Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
2) Ream or file pipe to remove burrs.
3) Clean and polish contact surfaces of joints.
4) Apply flux to both male and female ends.
5) Insert end of tube into full depth of fitting socket.
6) Heat joint evenly.
7) Form continuous solder bead around entire circumference of joint starting at the bottom.

b. Threaded Joints:
1) When open flames for soldering are impractical, or at unions and connections to equipment and appurtenances, assemble copper tubing with flared ends as permitted by authority having jurisdiction.
2) Ends of tubing shall be flared at an angle of 45 degrees with flaring tool recommended by pipe manufacturer. Flaring tool shall have same outside diameter as tube to be flared.
3) Tubing to be flared shall be soft temper or annealed prior to flaring.
4) End of tube shall be cut square and reamed to remove burrs.
5) Tube that is out-of-round shall be resized back to round.
6) Clean and polish contact surfaces of joints using an abrasive cloth.
7) Place flare nut over the end of tube with threads closest to end being flared.
8) Insert appropriate length of tube between flaring bar of flaring tool and position the yolk with flaring cone over tube end and clamp yoke in place.
9) Turn handle of yolk clockwise without over-tightening. Cracked or deformed tubes will be rejected.
10) Do not apply jointing compounds to mating surfaces of flare fitting and flared tube end before attaching flare nut to threaded connection.

6. Mechanical Coupling Joints:

a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.
b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.

I. Backfilling:
1. Conform to applicable requirements of Section 31 23 05, Excavation and Fill.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

J. Connections to Valves and Hydrants:
1. Install valves and hydrants as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves or hydrants and piping have different joint types.
3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

K. Transitions from One Type of Pipe to Another:
1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
2. Provide isolation joints at all change in pipe materials and at all structures.

L. Closures:
1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to

buried pipe.

3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule in this Section. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.
d. Prestressed Concrete Cylinder Pipe (PCCP) AWWA C301, Bar Wrap Pipe (BWP) AWWA C303, or other concrete joints: restrain by welding. Welds may be segmented symmetrically or fully circumferential. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle thrust forces at maximum design stress of 12,500 psi. Thrust forces in

longitudinal must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for the concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M9..

E. Concrete Thrust Blocks:
   1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to 03 30 00, Cast-In-Place Concrete.
   2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
   3. Concrete thrust block size shall be as shown on the Drawings or as approved by ENGINEER.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Underground Facilities:
   1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
   2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Taking Existing Pipelines and Underground Facilities Out of Service:
   1. Conform to Section 01 14 16, Coordination with Owner's Operations.
   2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 14 16, Coordination with Owner's Operations, or approved by ENGINEER.
   3. Notify ENGINEER in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 14 16, Coordination with Owner's Operations.

C. Work on Existing Pipelines or Underground Facilities:
   1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
   2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
   3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
   4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

A. General:
   1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
   2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
   8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
   9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of OWNER. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:
   1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
   2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Buried Piping Schedule in this Section:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.

b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
c. Disinfect for bacteriological testing piping that conveys potable water.

4. Test Pressure:
   a. Use test pressures listed in Buried Piping Schedule in this Section.
   b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing:
   a. For thermoplastic pipe and fiberglass pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
   b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
   c. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
   d. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.
   e. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.

2. Test Procedure:
   a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
   b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
   c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
   d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
   f. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
   g. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do

not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.

h. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in ANSI/AWWA Manual M41:
      1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Bell and spigot and push-on joints.
         b) Mechanical joints.
         c) Bolted sleeve type couplings.
         d) Grooved and shouldered couplings.
   c. Rates based on make-up allowance in ANSI/AWWA Manual M9:
      1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.
   d. Rates based on formula or table in ANSI/AWWA C605:
      1) Plastic pipe joined with O-ring gasket sealing members.
   e. Rates based on formula or table in ANSI/AWWA C603:
      1) Asbestos-cement pipe.

D. Sewer Testing with Low Pressure Air:
   1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
   2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
   3. Test in accordance with requirements of authority having jurisdiction.
   4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
      a. Thermoplastic and HDPE Pipe: ASTM F1417.
      b. Concrete Pipe: ASTM C924.
      c. Clay Pipe: ASTM C828.

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E. Vertical Deflection Test for Thermoplastic, FRP, and HDPE Pipe, Steel:
   1. Conduct vertical deflection test at least thirty days after backfill has been placed.
   2. Manually pull pin-type vertical gauge mounted on sled through pipe. Gauge shall be manufactured by Quality Test Products, or equal. Set gauge so that sled will stop if vertical deflection of pipe exceeds five percent. Excavate and re-install piping that fails deflection test, and retest.
   3. Use rigid ball or mandrel for deflection test, which shall have diameter of at least 95 percent of base inside diameter or average inside diameter of piping, depending on which is specified in applicable ASTM standard, including appendix, to which pipe is manufactured. Perform test without mechanical pulling devices. Re-install and retest pipe segments that exceed deflection of five percent.

F. Televised Inspection:
   1. Televise completed sewer and appurtenant structures, including manholes and chambers, and provide to ENGINEER copy of video on digital video disc (DVD). Repair apparent leaks and re-televise the pipe until acceptance by ENGINEER.
   2. Inspection shall be performed by Subcontractor certified in Pipeline Assessment Certification Program (PACP) by National Association of Sewer Service Companies (NASSCO). Provide copy of PACP certification prior to starting inspection. Televising shall conform to coding and reporting standards and guidelines specified in PACP. Use same standards for lateral inspections, regardless of whether conducted using cleanout-launched or mainline-launched lateral camera. Identify report annotations, pipe conditions, and pipe defects in accordance with PACP. Severity ratings shall be calculated in accordance with PACP.
   3. Camera for main line shall be pan-and-tilt, radial viewing, pipe inspection camera that pans plus-or-minus 275 degrees and rotates 360 degrees. Use camera with an accurate footage counter that displays on television monitor exact distance of camera from centerline of starting manhole. Use camera with height adjustment so that lens is always centered at one-half inside diameter or higher, in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Camera shall operate in 100 percent humidity. Camera, television monitor, and other components of video system produce a minimum 450-line resolution colored video picture. Picture quality and definition shall be satisfactory to ENGINEER. Camera for lateral televising shall be fixed and capable of moving from main line 80 feet up lateral, and conform in other respects to requirements for main line camera.
   4. Repair apparent leaks in pipe Work in manner satisfactory to ENGINEER without additional cost to OWNER and re-televise the pipe.

G. Examination of Welds:
   1. Personnel performing examination of welds shall be qualified to at least Level II in accordance with ASNT SNT-TC-1A.
   2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
   3. Visually examine all welds, Category D Fluid Service, in conformance with ASME B31.3.
   4. Examine at least ten percent of welds using liquid penetrant examination.
   5. If defect is detected, all welds shall be examined by liquid penetrant examination.
   6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

H. Bacteriological Testing:
   1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule, is specified in Article 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:

1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.

B. Disinfection:
   1. Disinfect all potable and finished water piping.
   2. Suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by ENGINEER.
      a. Prior to disinfection, clean piping as specified and flush thoroughly.
      b. Conform to procedures described in ANSI/AWWA C651. Use continuous feed method of disinfecting, unless alternative method is acceptable to ENGINEER.
   3. Water for initial flushing, testing, and disinfection will be furnished by OWNER. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for redisinfection will be paid by CONTRACTOR to OWNER at water utility's standard rates.
   4. Chlorine shall be provided by CONTRACTOR.
   5. Bacteriologic tests will be performed by OWNER. Certified test laboratory report will be provided to CONTRACTOR, if requested.
   6. Chlorine concentration in water entering the piping shall be between 50 and 100 ppm, such that minimum residual concentration of 25 mg/L remains after 24-hour retention period. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
   7. After required retention period, flush chlorinated water to closed drain line, unless otherwise acceptable to ENGINEER. Properly dispose of chlorinated water in accordance with Laws and Regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.7 CATHODIC PROTECTION

A. General:
   1. Provide cathodic protection for buried steel pipelines. Refer to Section 26 24 16.2 Cathodic Protection for Pipelines
   2. Provide insulated joint at each of the following:
      a. Connection to steel water tanks and each branch connecting to a water line.
      b. Connection between concrete pipe and steel pipe, and between ductile iron pipe and steel pipe.
      c. Connection through wall.
      d. Where indicated.
   3. Provide electrical bond across all other gasketed steel pipe joints.
   4. Provide test lead stations for monitoring electrical currents on pipeline at locations shown and indicated in the Contract Documents.

B. Details of Cathodic Protection:
   1. Insulated Joints: Where shown or indicated in the Contract Documents, provide insulated flange type joints. After joint is made, provide exterior coating around joint as specified for piping being joined.
   2. Electrical Bond Across Rubber Gasket Joints: Provide two electrical bonding cables across each rubber-gasketed bell and spigot joint. Before exterior coating is applied to bell and spigot joints, two small areas of metal shall be exposed on each side of joint, one on spigot ring and one on bell. Thoroughly clean each area and bond two cathodic protection cables to pipe, one on each side of joint. Bond each cable by thermite process. Coat completed connections and exposed metal as specified for exterior coating of pipe being joined.
   3. Electrical Bond Across Mechanical Couplings: Provide two electrical bonding cables across each mechanical coupling. Before the exterior coating is applied to mechanical couplings, expose two small areas of metal on pipe surface on each side of coupling, on middle ring and on each follower ring of coupling. Thoroughly clean each area and bond two cathodic protection cables to pipe, one on each side of joint and to middle ring and follower rings of mechanical coupling. Bond each cable by thermite process. Coat completed connections and exposed metal as specified for exterior coating of pipe being joined.
   4. Electrical Bond Across Valves and Flanges: Provide two electrical bonding cables across valves and flanged connections other than insulated flange type joints. Provide electrical bond as specified for bond across rubber gasket joints.
   5. Test Lead Stations: Provide test lead stations where shown and indicated in the Contract Documents. Terminate test lead on ground surface in standard connection box at a protected location acceptable to ENGINEER.

3.8 SCHEDULES

A. Schedules listed below, following the “End of Section” designation, are part of this Specification section.
   1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class / Thickness	Joint	Test	Remarks
FW	30	DI	CL	AS (Note 3)	350/Special Class 53	RBS, FEC, FLG	HYD (100)	Restrain all joints
FW	16	DI	CL	AS (Note 3)	350/Special Class 53	RBS, FEC, FLG	HYD (100)	Restrain all joints
FW	20	CS	CL	PU	Note 1	FEC, FLG, LW	HYD (100)	Restrain all joints

Notes:

1. Reference Section 40 05 24.23 Steel Process Pipe.
2. Reference Paragraph 2.1 D and 3.1 G of this Section for polyethylene encasement material and installation requirements.
3. WL installation requires use of DI fittings with asphaltic coating (AS). Reference Section 40 05 05-A Exposed Piping Schedule for non-asphaltic coating requirements on exposed pipe.
4. Test to 100 psi unless specifically noted on the drawings.

The following abbreviations are used in the Buried Piping Schedule

A. Service Abbreviations

Service	Abbrev	
Finished Water	FW	
Water Line	WL	

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Carbon Steel	CS		Ductile Iron	DI

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Polyurethane	PU
Asphaltic Coating	AS			

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Flexible End Coupling	FEC		Flanged	FLG
Restrained Bell and Spigot	RBS		Lap Weld	LW

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Chlorine Pipe Test	CL		Hydrostatic Test (test pressure in psig)	HYD ( )

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SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections.
      b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
      c. Work on or affecting existing exposed piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
      e. Supports, restraints, and other anchors.
      f. Field quality control, including testing.
      g. Cleaning and disinfecting.
      h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Mechanical.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 10 14 00, Signage.
   3. Section 40 05 07, Pipe Hangers and Supports.
   4. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   5. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.
   6. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
   2. ASME Boiler and Pressure Vessel Code.
   3. ASME B31.3, Process Piping.
   4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
   6. ASTM B32, Specification for Solder Metal.
   7. ASTM D4161, Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
   8. ASTM D4174, Standard Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
   9. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
   10. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   11. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   12. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
   13. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   14. ANSI/AWWA C606, Grooved and Shouldered Joints.
   15. ANSI/AWWA C651, Disinfecting Water Mains.
   16. AWWA M9, Concrete Pressure Pipe.
   17. AWWA M11, Steel Pipe - A Guide for Design and Installation.
   18. AWWA M23, PVC Piping - Design and Installation.
   19. AWWA M41, Ductile-Iron Pipe and Fittings.
   20. AWWA M45, Fiberglass Pipe Design.
   21. AWWA M55, PE Pipe - Design and Installation.
   22. SAE J1227, Method for Assessing the Cleanliness Level of New Hydraulic Fluid.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
      a. City of Arlington, TX

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings in plan and, as applicable, section.

b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.

2. Testing Plans, Procedures, and Testing Limitations
   a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
      b. Welder's certificate in compliance with Paragraph 3.1.E.7.c of this Section.
   2. Source Quality Control Submittals:
      a. Submit copies of testing report for each test.
   3. Site Quality Control Reports:
      a. Submit copies of testing report for each test.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
      b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
      c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
      d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver products to Site to ensure uninterrupted progress of the Work.
   2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
   3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage:
   1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.

2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.

C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free of dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.

B. Markings and Identification:
1. Pipe Markings:
a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

C. Appurtenances: Provide products that comply with:
1. Section 40 05 07, Pipe Hangers and Supports.
2. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
   2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
   3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.

B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
   1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
   3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
   4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.

C. Piping Installation:
   1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
      a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
      b. Concrete Pipe: AWWA M9.
      c. Steel Pipe: ASME B31.3, ANSI/AWWA C206, AWWA M11.
      d. Thermoplastic Pipe: AWWA M23
      e. Fiberglass Reinforced Plastic Pipe: AWWA M45
      f. Polyethylene Pipe: AWWA M55
   2. Install straight runs true to line and elevation.
   3. Install vertical pipe truly plumb in all directions.
   4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
   5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
   6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.

7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.

D. Jointing Pipe:
   1. General:
      a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
      b. Cut piping accurately and squarely and install without forcing or springing.
      c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
      d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
   2. Ductile Iron and Steel Flanged Joints:
      a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
      b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
      c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
      d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
      e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
      f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
   3. Field Welded Steel Pipe Joints:
      a. Joints in steel pipe shall be butt welded or lap welded, except that flexible couplings, mechanical couplings, or flanged connections shall be provided at connections to valves, meters, and similar equipment, and where shown or specified.
      b. Welding procedures and welder qualifications shall conform to ASME Boiler and Pressure Vessel Code Section IX or to American Welding Society Structural Welding Code D1.1/D1.1M, Section 5, whichever is

required. Welding of steel water pipe shall conform to the requirements of AWWA C206.

c. For all piping, submit current certificates that all welders and welding operators have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX or American Welding Society Structural Welding Code D1.1/D1.1M, Section 5, whichever is required.
d. Conform to field welding procedures recommended by pipe manufacturer and as specified herein.
e. Clean ends to be welded up to at least 1/2-inch beyond the estimated toe of weld by sandblasting or other means to remove surface contamination such as paint, oil, grease, scale, oxide, rust, and other contamination.
f. Verify that ends to be welded are adequately prepared in shop for welding.
g. Provide full penetration welds, free of cracks, overlap and cold laps.
h. Preheat and interpass temperatures shall be not less than 60 degrees F and not more than 350 degrees F, respectively.
i. Limit on Undercut: 1/32-inch or ten percent of base metal thickness, whichever is less.
j. For pipe wall thickness up to 11-gauge (0.125-inch) use GTAW (Gas Tungsten Arc Welding).
k. For pipe wall thickness greater than 11-gauge, use GTAW root pass followed by GMAW (Gas Metal Arc Welding) or SMAW (Shielded Metal Arc Welding) Cap.
l. Where required for pipes 36-inch diameter and larger, and heavier-wall pipes, provide joints double beveled and welded from both inside and outside with the flux core process.
m. Provide internal inert gas purge to exclude atmosphere.
n. Filler Wire: ELC grade, of matching composition or of higher molybdenum content.
o. Weld Thickness: Equal to or greater than parent metal. Strength of welded joints shall be equal to or greater than strength of pipes being joined.
p. All welds shall be smooth with an internal crown of 1/16-inch or less, and external crown of 3/32-inch or less.
q. For grinding operations, use iron-free grinding wheels.
r. After welding, joint and the surrounding damaged or uncoated area shall be coated with same coating and thickness as shop applied coating.
s. Tack Welds: Make tack welds when required to aid in joining, with same grade of filler metal as for finished welds. For finish welding, either completely remove tack welds or grind starting and finishing ends of tack welds for incorporation into finished welds.
t. Clean and de-scale all welds per ASTM A380.

4. Steel Pipe Threaded Joints:
   a. For threaded joints, use standard, right hand tapered full depth threads on steel piping and apply a manufacturer's recommended joint compound to male threads only, before installation.
   b. Remove cuttings and foreign matter from inside of pipe.

c. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.

E. Installing Valves and Accessories:
1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:
1. Install dielectric unions as specified in Section 40 05 06, Couplings, Adapters, and Specials for Process Piping**,** where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Closures:
1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.

C. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.

3.3 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
   1. Locations of existing piping shown on Drawings is approximate.
   2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.

B. Taking Existing Pipelines Out of Service:
   1. Conform to Section 01 14 16, Coordination with Owner's Operations.

C. Work on Existing Pipelines:
   1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
   2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
   3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
   4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations and Section 01 73 24, Connections to Existing Facilities.

3.4 PAINTING

A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

A. Testing, General:
   1. Test all piping, except as exempted in the Exposed Piping Schedule.
   2. Notification:
      a. Notify ENGINEER at least 48 hours prior to testing.
      b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.

8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.

B. Test Schedule:
   1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
   2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Exposed Piping Schedule:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
      b. Disinfect for bacteriological testing piping that conveys potable water.
   4. Test Pressure:
      a. Use test pressures listed in Exposed Piping Schedule.
      b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For steel pipe, follow procedures described in AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
      b. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
      c. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
   2. Test Procedure:
      a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
      b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
      c. Examine joints and valves, and make repairs to eliminate visible leakage.
      d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.

e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
f. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
g. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three-hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.
h. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen-minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in AWWA Manual M41:
      1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Bell and spigot and push-on joints.
         b) Mechanical joints.
         c) Bolted sleeve type couplings.
         d) Grooved and shouldered couplings.
   c. Rates based on make-up allowance in AWWA Manual M9:
      1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.
   d. Rates based on formula or table in ANSI/AWWA C605:
      1) Plastic pipe joined with O-ring gasket sealing members.

D. Exfiltration Testing:
   1. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment.
   2. Before measuring leakage, allow fluid to wet pipe interior for the following period:
      a. Concrete Pipe: 48 hours.
      b. Cement Mortar-lined Pipe: 24 hours.
      c. Other Pipe: Wetting period not required.
   3. Provide a minimum hydrostatic head during test of two feet above highest point of pipe segment tested.

4. Add fluid from a test container or from a metered supply as required to maintain the test water level within three inches of the test head throughout the test.
5. Test duration shall be at least two hours.
6. Allowable Leakage Rates:
    a. Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain the hydrostatic head within three inches of test head during the test after pipe has been filled and exposed to required wetting period, plus the quantity required to refill to original head at end of test.
    b. Allowable leakage shall be Zero.

E. Examination of Welds:
1. Personnel performing examination of welds shall be qualified to at least Level II, in accordance with ASNT SNT-TC-1A.
2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
3. Visually examine all welds, Category D Fluid Service, in conformance with ASME B31.3.
4. Examine at least ten percent of welds using liquid penetrant examination.
5. If a defect is detected, all welds shall be examined by liquid penetrant examination.
6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

F. Bacteriological Testing:
1. Bacteriological testing for potable water lines, finished water lines, and other piping per Exposed Piping Schedule, is specified in Article 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:
1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution.

B. Cleaning of Hydraulic and Fluid Power Oil Systems: Upon completion of field piping, but before connection to control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness

Level (ACL). Unless otherwise specified, ACL value shall be established by manufacturer of major hydraulic system components in accordance with SAE J1227, Section 9.1.

C. Disinfection:
   1. Disinfect all potable and finished water piping.
   2. A suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by ENGINEER.
      a. Prior to disinfection, clean piping as specified and flush thoroughly.
      b. Conform to procedures described in ANSI/AWWA C651. Continuous feed method of disinfecting shall be used, unless alternative method is acceptable to ENGINEER.
   3. Water for initial flushing, testing, and disinfection will be furnished by OWNER. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for re-disinfection will be paid by CONTRACTOR to OWNER at the water utility's standard rates.
   4. Chlorine shall be provided by CONTRACTOR.
   5. Bacteriologic tests will be performed by OWNER. A certified test laboratory report will be provided to CONTRACTOR, if requested.
   6. Chlorine concentration in the water entering the piping shall be between 50 and 100 ppm, such that a minimum residual concentration of 25 mg/l remains after a 24-hour retention period. Disinfect the piping and all related components. Repeat as necessary to provide complete disinfection.
   7. After required retention period, the chlorinated water shall be flushed to a closed drain line, unless otherwise directed by ENGINEER. Properly dispose of chlorinated water in accordance with applicable regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.7 EXPOSED PIPING SCHEDULE

TABLE 40 05 05-A
EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test
FW	16	DI	CL	P (See Note 1)	150	FLG	HYD (225)

Note 1: Ductile Iron Pipe manufacturer shall provide Factory Primed Coat for field color paint.

Abbreviations and Notes:
FW: Finished Water

DI: Ductile Iron
CL: Cement Mortar Lined
P: Painted
FLG: Flanged
HYD(225): Hydrostatic Test at 225 psi

+ + END OF SECTION + +

40 05 06 COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for process piping.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for process piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation
   3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
   3. ASME B31, Standards of Pressure Piping.
   4. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A105/A105M, Specification for Carbon Steel Forgings and Piping Applications.
   6. ASTM B169/B169M Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.
   7. ASTM B650, Specification for Electro-Deposited Engineering Chromium Coatings of Ferrous Substrates.
   8. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain each type of coupling, adapter, and special for process piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.
   2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.

3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
   2. Manufacturer's Instructions:
      a. Provide instructions for handling, storing, installing, and adjusting of products.
   3. Source Quality Control:
      a. When requested by ENGINEER, submit results of source quality control tests.
   4. Qualifications Statements:
      a. Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:
   1. Pressure and Service: Same as connected piping.
   2. Products and Manufacturers: Provide products of one of the following:
      a. Style 253, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
      b. Style 441, by Smith Blair, Inc.
      c. Or equal.
   3. Material:
      a. Steel (for steel pipe)
      b. Ductile iron (for ductile iron pipe)
   4. Gaskets: Suitable for specified service, as recommended by manufacturer.
   5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.

6. Harnessing: Provide harnessing as specified below unless otherwise shown in the Contract drawings.
    a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
    b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
    c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
    d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
7. Remove pipe stop(s) if used, unless otherwise shown or specified.

B. Flanged Coupling Adapters:
1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
2. Products and Manufacturers: Provide one of the following:
    a. Style 227, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
    b. Style 912, by Smith Blair, Inc.
    c. Or equal.
3. Pressure and Service: Same as connected piping.
4. Material:
    a. Steel (for steel pipe)
    b. Ductile iron (for ductile iron pipe)
5. Gasket: As recommended by the manufacturer
6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
7. Harnessing: Provide harnessing as specified below unless otherwise shown in the Contract drawings.
    a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
    b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by ENGINEER.
        1) Six-inch Diameter and Smaller: Two
        2) Eight-inch Diameter and Smaller: Four
        3) Ten-inch Diameter and Smaller: Six

4) Twelve-inch Diameter and Smaller: Eight

c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.

C. Split-type Grooved or Shouldered End Couplings:

1. Pressure and Service: Same as connected piping. Use shouldered end where required by pressure rating.
2. Products and Manufacturers:
   a. For coupling of cast-iron or ductile iron pipe, provide products of one of the following:
      1) Style 31, as manufactured by Victaulic Company.
      2) Series 500, as manufactured by Tyler Pipe, Gustin Bacon Division.
      3) Gruvlok Figure 705, as manufactured by Grinnell Mechanical Products, division of Tyco.
      4) Or equal.
   b. For coupling of standard steel pipe, where joint deflection is desired or allowed, provide products of one of the following:
      1) Style 77, as manufactured by Victaulic Company.
      2) Series 1000, as manufactured by Tyler Pipe, Gustin Bacon Division.
      3) Or equal.
   c. For coupling of standard steel pipe, where joint deflection is not desired or allowed, provide products of one of the following:
      1) Style HP-70, as manufactured by Victaulic Company.
      2) Series 110, as manufactured Tyler Pipe, Gustin Bacon Division.
      3) Or equal.
   d. For coupling of stainless-steel pipe, provide products of one of the following:
      1) Style 77-S, as manufactured by Victaulic Company.
      2) Or equal.
   e. For coupling of aluminum pipe, provide products of one of the following:
      1) Style 77A, as manufactured by Victaulic Company.
      2) Series 101, as manufactured by Tyler Pipe, Gustin Bacon Division.
      3) Or equal.
   f. For coupling of thermoplastic pipe, provide products of one of the following:
      1) Style 774, as manufactured by Victaulic Company.
      2) Or equal.
3. Couplings shall conform to applicable requirements of AWWA C606.
4. Housing Material:
   a. For coupling of cast-iron pipe, ductile iron pipe, steel pipe, and thermoplastic pipe: Malleable iron or ductile iron.
   b. For coupling of stainless-steel pipe: Type 304 stainless steel, or equal.
   c. For coupling of aluminum pipe: Aluminum alloy 356-T6.
5. Gaskets: As recommended by the manufacturer

6. Bolts and Nuts: Heat-treated carbon steel track bolts, plated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.

D. Flanged Adapters (Dismantling Joints):
   1. Description: Telescoping, flanged spool piece with tie rod:
   2. Pressure and Service: Same as connected piping.
   3. Material: Adapters 24-inches and smaller shall be ductile iron or steel. Adapters larger than 24-inches shall be steel.
   4. Gasket: Recommended by the manufacturer suitable for potable water service.
   5. Bolts and Nuts: Type 316 Stainless steel.
   6. Harnessing:
      a. Harness adapters to restrain pressure piping. Test pressures for pressure pipelines are included in the piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
      b. For adapters 12-inch diameter and less provide 1/2- inch minimum Type 316 stainless steel anchor studs installed in a pressure tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer. However, the following minimum anchor studs shall be provided unless otherwise approved by ENGINEER.
         1) 6-inch Diameter and Less: Two
         2) 8-inch Diameter and Less: Four
         3) 10-inch Diameter and Less: Six
         4) 12-inch Diameter and Less: Eight
      c. For dismantling joints on the suction and discharge of any pump, the restraining tie-rods shall be sized in accordance with ANSI/HI 1.4.3.5.2 which limits the maximum axial deflection to 0.005 inch.
      d. For adapters larger than 12-inch diameter provide split-ring harness clamps with a minimum of four corrosion resistant alloy steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
   7. Products and Manufacturers: Provide one of the following:
      a. Style 975 Dismantling Joint, as manufactured by Smith-Blair.
      b. Style 127, as manufactured by Dresser Industries.
      c. DJ400, as manufactured by Romac Industries, Inc.

2.2 MISCELLANEOUS SPECIALTIES AND ACCESSORIES

A. Dielectric Connections:
   1. General: Where copper pipe connects to steel pipe, cast-iron pipe, or ductile iron pipe, provide either dielectric union or an insulating section of rubber or plastic pipe. When used, insulating section shall have minimum length of 12 pipe diameters.
   2. Manufacturers: Provide products of one of the following:
      a. Epco Sales, Inc.
      b. Watts Regulator Company.
      c. Capitol Manufacturing Company.

d. Or equal.

3. Dielectcric Unions: Rated for 150 psi, ANSI B16.39.
4. Insulating Sections: Rated for same pressure as associated piping test pressure. Material shall be suitable for the application and service.

2.3 PAINTING

A. Shop Painting:
   1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09 91 00, Painting, unless otherwise specified in this Section.
   2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

A. Installation:
   1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
   2. For buried installations, refer to Section 33 05 05, Buried Piping Installation.
   3. For exposed installations, refer to Section 40 05 05, Exposed Piping Installation.

B. Adjust expansion joints as required to ensure that expansion joints will be fully extended when ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which expansion joints are installed.

+ + END OF SECTION + +

40 05 07 PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 05 50 13, Miscellaneous Metal Fabrications.
   3. Section 09 91 00, Painting.
   4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
      b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   2. Federal Specification, (FS).
      a. FS A-A-1192, Hangers, Pipe.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
      a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
      b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
   4. Underwriters' Laboratories, Inc., (UL).
      a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

A. Each type of pipe hanger or support shall be the product of one manufacturer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
   2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
      b. Each pipe system shall be analyzed for all loads and forces on the hangers and supports. Provide calculations of reaction forces to the structure to which they are fastened. Provide confirmation that hanger systems comply with support requirements and codes.
      c. Submit and coordinate these with Shop Drawings required for all piping systems.
   2. Product Data:
      a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:

1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
3. Install hangers or supports at all locations where pipe changes direction.
4. All hangers and supports shall be capable of adjustment after placement of piping.
5. Different types of hangers or supports shall be kept to a minimum.
6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)			
	Steel	Copper	Plastic [2]	Cast/Ductile Iron [4]
3/8 to 3/4	5	6	Cont. [3]	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	-
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	
18	12	-	-	10 feet for soil pipe
20	12	-	-	
24	12	-	-	

[1]Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

[2]Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

[3]Continuous means pipe shall be in unistrut or similar channel.

[4] Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130ºF shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless-steel hangers or supports.
14. Isolate thin walled stainless-steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
1. $\Delta L = L \times \Delta T \times \alpha$
    a. Where ΔL = pipe length change (inches).
    b. L = pipe length between anchors (inches).
    c. ΔT = 100 (F).
    d. α = coefficient of thermal expansion (inches/inches/F).
2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
3. Expansion compensation shall be achieved via expansion joints specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

2.2 HANGERS AND SUPPORTS

A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.

B. Products and Manufacturers: Provide one of the following:
1. Anvil International, Inc.
2. Elcen.
3. B-Line.
4. Unistrut Corporation.
5. Or equal.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
1. Concrete inserts shall be MSS SP 58 malleable Type 18.

2. Concrete inserts shall be of the continuous type capable of supporting 2,000 pounds per foot of insert as shown.
3. Manufacturers: Provide products of one of the following:
    a. Unistrut Corporation, Wayne, Michigan.
    b. Elcan Metal Products, Company, Franklin Park, Illinois.
    c. B-Line.
    d. Anvil International, Inc.
    e. Or equal.

C. Steel Beam Clamps:
1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58 Type 28.

D. Inserts for Pipe Insulation:
1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.

E. Brackets:
1. Brackets for wall mounting shall conform to MSS SP 58 Type 32 or 33 as required.

F. Pipe Roll:
1. To provide for pipe expansion, pipe shall be supported on adjustable malleable or steel pipe rolls, Type 46.

G. Fabricated Pipe Rack:
1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Field painting shall conform to the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
   5. Maximum spacing for horizontal piping:
      a. Steel 1-Inch and Smaller: Seven feet.
      b. Steel 1-1/2-Inch and Larger: Ten feet.
      c. Brass or Copper 3-Inch and Smaller: Seven feet.
      d. Brass or Copper 4-Inch and Larger: Ten feet.
      e. Additional supports at:
         1) Change in direction.
         2) Branch piping and runouts over five feet.
         3) Concentrated loads due to valves, strainers or other similar items.
      f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
   6. Hanger types for horizontal piping, except as noted and shown:
      a. Forged steel adjustable clevis type, rod support for all services.
      b. Slide Bases:
         1) Pipe stand, brackets, trapeze or other equivalent structural support.
         2) For piping 2-inches or larger.
      c. For pipe and covering provide:
         1) Saddles for rollers or slide bases.
         2) Protective shields or saddles for all other types of supports.
      d. Threaded Steel Rods:
         1) Two inch vertical adjustment with two nuts each end for positioning and locking.
         2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

3) For Double Rod Hangers: One size smaller than above.
4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) 25 feet for piping to 2-inches.
      2) 36 feet for piping 2-1/2-inches or larger.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.
      2) Provisions for expansion.
   d. Intermediate Supports: Steel pipe clamp at floor.
      1) Bolted and welded to pipe.
      2) Extension ends bearing on structural steel or bearing plates.
   e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.
8. Insulated Piping:
   a. Horizontal Pipe Shields at Supports:
      1) Minimum 120 degree arc.
      2) Length equal to diameter of insulation 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
   b. Vertical Pipe Shields at Guides:
      1) Full 360 degree arc, securely banded.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.

G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

+ + END OF SECTION + +

40 05 19 DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
   2. Extent of piping is shown on the Drawings. Piping schedule in Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation
   2. Section 40 05 05, Exposed Piping Installation.
   3. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
   2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
   3. ASTM A193, Alloy Steel and Stainless-Steel Bolting Materials for High-Temperature Service.
   4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
   10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
   11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
   13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
   14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).

15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
   2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop

Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.

3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:
1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 40 05 05, Exposed Piping Installation and Section 33 05 05 Buried Piping Installation:
1. Shop Drawings:
   a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
2. Product Data:
   a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
3. Samples:
   a. Submit Sample of pipe and fitting with each type of lining, for use at the Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.
4. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
   b. Submit certificate signed by applicator of the linings and coatings stating that product to be applied conforms to applicable referenced standards and that the applicator shall conform to the Contract Documents.
2. Source Quality Control Submittals:
   a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
   b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 40 05 05, Exposed Piping Installation and Section 33 05 05 Buried Piping

Installation.

B. Handling of Fittings Coated with Fusion Bonded Epoxy: Hooks, forks, chains, straps, and other lifting devices shall be rubber-coated and be used only on exterior of fittings in manner to avoid damaging coating. If coating becomes damaged, notify pipe and coating manufacturer to determine if repair of damaged area or re-coating is required. Perform repairs using recommended procedures and materials provided by manufacturer, as accepted by ENGINEER. Pipe and fittings requiring re-coating shall be removed from Site and returned to manufacturer's facility. Repaired or re-coated pipe and fittings shall comply with requirements of this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Piping systems shall be suitable for their intended use.
   2. Joints shall be as specified in Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:
   1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
      a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
   2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
      a. Pressure Class: As specified in piping schedules in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Pressure Class 150.
      b. Special Thickness Class: As specified in piping schedules in Section 40 05 05, Exposed Piping Installation.
   3. Pipe Joints:
      a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
         1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
         2) Bolts: Comply with ANSI B18.2.1.
            a) Exposed: ASTM A307, Grade B.
            b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex,

Type 316 stainless steel.

3) Nuts: Comply with ANSI B18.2.2.
   a) Exposed: ASTM A563, Grade A, Heavy hex.
   b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.

b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 40 05 05, Exposed Piping Installation.
   1) Glands: Ductile iron.
   2) Gaskets: Plain tip.
   3) Bolts and Nuts: High strength, low alloy steel.
   4) Manufacturers: Provide products of one of the following:
      a) Clow Water Systems Company
      b) Atlantic States Cast Iron Pipe Company
      c) Canada Pipe Company, Ltd.
      d) McWane Cast Iron Pipe Company
      e) Pacific States Cast Iron Pipe Company
      f) Griffin Pipe Products Co.
      g) American Cast Iron Pipe Co.
      h) U.S. Pipe and Foundry Co.
      i) Or equal.

c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 40 05 05, Exposed Piping Installation.
   1) Gaskets: Vulcanized SBR, unless otherwise specified.
   2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
   3) Products and Manufacturers: Provide one of the following:
      a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
      b) Fastite Joint by American Cast Iron Pipe Company.
      c) Tyton Joint by U.S. Pipe and Foundry Company.
      d) Or equal.

d. Grooved End Joints: Comply with ANSI/AWWA C606.
   1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
   2) Bolts and nuts: As specified for flanged joints.
   3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
   4) Products and Manufacturers: Provide one of the following:
      a) Victaulic, Style 31.
      b) Or equal.

e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
   1) Products and Manufacturers: Provide restrained joints for mechanical joint

piping by one of the following:
a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
b) MJ Coupled Joint, by American Cast Iron Pipe Co.
c) MJ Field Lok, by U.S. Pipe and Foundry Co.
d) Or equal.

2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
c) TR Flex Joint, by U.S. Pipe and Foundry Company.
d) Snap-Lok, by Griffin Pipe Products Company.
e) Or equal.

4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
a. Material: Ductile iron.
b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.

5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
a. Material: Ductile iron.
b. Glands: Ductile iron.
c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Lining, General:
1. Typical Service Conditions:

Property	Value
Fluid(s) Conveyed Through Pipe	Finished Water
pH range	6 – 9
Temperature Range (degrees F)	32 – 110
Maximum Fluid Velocity (fps)	8
Lining Type	Cement Mortar

2. Surface Preparation:
a. Initial Surface Inspection: Surface to be lined shall be inspected by pipe and fitting manufacturer and applicator, if applicator is other than pipe and fitting manufacturer. Inspecting parties shall inspect surface to be coated and mutually determine recommended surface preparation method.
b. Surface Preparation: Prepare surface in accordance with recommended method.
c. Finished Surface Inspection: Lining applicator shall inspect finished surface prior to application to determine acceptability. If surface is

unacceptable, repeat surface preparation as necessary.

D. Cement-mortar Lining:
   1. Where specified in piping schedules included with Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.

E. Couplings:
   1. Refer to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

I. Specials:
   1. Transition Pieces:
      a. Provide suitable transition pieces (adapters) for connecting to existing piping.
      b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
   2. Taps:
      a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
      b. Provide corporation stops where shown or required.
      c. Where pipe wall thickness or tap diameter will not allow engagement of full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
      d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
   3. Tangential Outlets:
      a. Provide tangential outlet fittings where shown or indicated.
      b. Weld-on fittings are acceptable.
      c. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

A. In addition to identification markings specified in Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
   1. Name or trademark of manufacturer.
   2. Weight, class or nominal thickness, and casting period.
   3. Country where cast.
   4. Year the pipe was produced.
   5. Letters “DI” or “Ductile” shall be cast or metal stamped

B. In addition to identification markings specified in Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
   1. Flange manufacturer’s mark, size, and letters “DI” cast or stamped on the flanges.
   2. Fabricator’s mark if other than flange manufacturer.
   3. Length and weight.

C. In addition to identification markings specified in Section 40 05 05, Exposed Piping

Installation, also stamp, mark, and identify fittings with:

1. Manufacturer's identification.
2. Pressure rating.
3. Nominal diameters of openings.
4. Country where cast.
5. Number of degrees or fraction of the circle on bends.
6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

A. General Coating Requirements:
   1. Coating types are specified in piping schedules in Section 40 05 05, Exposed Piping Installation.

B. Exposed Pipe and Fittings:
   1. Surface Preparation:
      a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
      b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
      c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
   2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.
   3. Field painting shall comply with Section 09 91 00, Painting.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

B. Visually inspect at the Site coated or lined pipe and fittings with ENGINEER and compare to approved Samples to verify lining continuity, surface gloss, and color, as applicable. Notify pipe manufacturer of damaged or unacceptable products. Pipe manufacturer shall visit the Site and perform testing to verify conformance with the Contract Documents to determine if products require replacement or repair. Repair or replace unacceptable products at no cost to OWNER.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

A. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

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40 05 24.23 STEEL PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install steel pipe and fittings.
2. Extent of piping is shown or indicated on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type(s), and Site quality control testing required.

B. Coordination:
1. Review installation procedures under this and other Specification Sections and coordinate the installation of items that must be installed with or before steel pipe Work.

C. Related Sections:
1. Section 09 91 00, Painting.
2. Section 33 05 05, Buried Piping Installation.
3. Section 40 05 05, Exposed Piping Installation.
4. Section 40 05 06, Couplings, Adapters, and Specialties for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. AASHTO, Policy on Geometric Design of Highways and Streets.
2. ANSI/ASME B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
3. ANSI/ASME B1.20.1, Pipe Threads, General Purpose, Inch.
4. ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
5. ANSI/ASME B16.3, Malleable Iron Threaded Fittings, Classes 150 and 300.
6. ANSI/ASME B16.4, Gray Iron Threaded Fittings (Classes 125 and 250).7. ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 Metric/Inch Standard.
8. ANSI/ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
9. ANSI/ASME B16.11, Forged Fittings, Socket-Welding and Threaded.
10. ANSI/ASME B18.2.1, Square and Hex Bolts and Screws, Inch Series.
11. ANSI/ASME B18.2.2, Square and Hex Nuts.
12. ANSI/ASME B31.3, Process Piping.
13. ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe.
14. ANSI/ASME Boiler and Pressure Vessel Code.
15. ASTM A36/A36M, Specification for Carbon Structural Steel.
16. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated Welded and Seamless.

17. ASTM A105/A105M, Specification for Carbon Steel Forgings for Piping Applications.
18. ASTM A106/A106M, Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
19. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
20. ASTM A139/A139M, Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
21. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
22. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
23. ASTM A197/A197M, Specification for Cupola Malleable Iron.
24. ASTM A234/A234M, Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
25. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
26. ASTM A536, Specification for Ductile Iron Castings.
27. ASTM A865, Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
28. ASTM D16, Terminology for Paint, Related Coatings, Materials, and Applications.
29. ASTM D297, Test Methods for Rubber Products – Chemical Analysis.
30. ASTM D395, Test Methods for Rubber Property – Compression Set.
31. ASTM D412, Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
32. ASTM D573, Test Method for Rubber – Deterioration in an Air Oven.
33. ASTM D1330, Specification for Rubber Sheet Gaskets.
34. ASTM D2240, Test Method for Rubber Property – Durometer Hardness.
35. ASTM D3359, Test Methods for Measuring Adhesion by Tape Test.
36. ASTM D3363, Test Method for Film Hardness by Pencil Test.
37. ASTM D4541, Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
38. ASTM D4752, Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub.
39. AWWA C200, Standard for Steel Water Pipe - 6 in. (150 mm) and Larger.
40. AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 In. (100 mm) and Larger, Shop Applied.
41. AWWA C206, Field Welding of Steel Water Pipe.
42. AWWA C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
43. AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings.
44. AWWA C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
45. ANSI/AWWA C218, Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.
46. AWWA C219, Bolted, Sleeve-Type Couplings for Plain End Pipe.

47. AWWA C222, Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
48. AWWA C606, Grooved and Shouldered Joints.
49. AWWA Manual M11, Steel Water Pipe: A Guide for Design and Installation.
50. AWS B2.1, Specification for Welding Procedure and Performance Qualification.
51. AWS D1.1/D1.1.M, Structural Welding Code – Steel.
52. Chlorine Institute, Pamphlet No. 6, Piping Systems for Dry Chlorine.
53. Chlorine Institute, Pamphlet No. 95, Gaskets for Chlorine Service.
54. NACE RP 0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
55. NACE RP 0274, High-Voltage Electrical Inspection of Pipeline Coatings.
56. NSF/ANSI 61, Drinking Water System Components – Health Effects.
57. SSPC-SP 1, Solvent Cleaning.
58. SSPC SP 6/NACE No. 3, Commercial Blast Cleaning.
59. SSPC-SP 10/NACE No. 2, Near-White Commercial Blast Cleaning.
60. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Pipe shall be the product of one manufacturer who has had not less than 5 years of successful experience manufacturing pipe, fittings, and specials and, where applicable, coating and lining of the particular type and size indicated. Experience to include successful fabrication of at least five crotch plate fittings within the past 5-year period. Pipe manufacturing operations (pipe, lining, and coating) shall be performed at one location unless otherwise approved by the ENGINEER. Fittings may be manufactured at an alternate location, provided they are supplied under the responsible authority of the pipe Manufacturer from the fitting Manufacturer that has had at least 5 years successful experience manufacturing fittings of the particular type and size indicated. All pipe shall be new and not supplied from inventory. All pipe and fittings shall be manufactured in the Continental U.S.A., and shipping over salt waterways will not be allowed.
      b. The Manufacturer shall be certified either under S.P.F.A. or ISO 9001 quality certification program for steel pipe and accessory manufacturing.
      c. Approved manufacturers are as listed in Part 2 of this Section.
   2. Welders:
      a. Shop welders: all personnel performing welding shall be qualified by testing in accordance with ASME BPVC SEC IX or AWS D1.1.
      b. Field welders: where field welds of steel pipe and components are allowed by ENGINEER each welder employed by the CONTRACTO shall be AWS D1.1 certified according to the Welding Procedure Qualification approved for the Project. All welders shall have been certified within the last 6 months or shall provide a welding continuity log to be allowed to weld on the line.
   3. Weld Inspectors:
      a. Inspection of shop welds and field welds , where field welds of steel pipe and

components are allowed by ENGINEER, shall be by certified weld inspectors, each having valid certificates conforming to ANSI/ASME Boiler and Pressure Vessel Code Section V, or AWS D1.1, as applicable for type of inspection required.

B. Component Supply and Compatibility:
   1. Unless otherwise approved by ENGINEER, obtain all pipe, fittings, and appurtenances included in this Section from a single steel pipe manufacturer.
   2. Steel pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all pipe, fittings, and appurtenances furnished under this Section.
   3. All components shall be suitable for specified service conditions and shall be integrated into the overall piping system by steel pipe manufacturer.
   4. Steel pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings.

C. Regulatory Requirements:
   1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable shall be certified by an accredited organization in accordance with NSF/ANSI 61-G as being suitable for contact with potable water, and shall meet requirements of authorities having jurisdiction at Site.

D. OWNER Testing and Inspection: Pipe manufacturing will be subject to additional inspected by the ENGINEER and subjected to independent testing at the direction of the OWNER. The ENGINEER shall have access to the Work whenever it is in preparation or progress, and the pipe Manufacturer shall provide proper facilities for access and for inspection. The pipe Manufacturer shall notify the ENGINEER in writing, a minimum of 2 weeks prior to the pipe fabrication so that the ENGINEER may advise the Manufacturer as to the decision of the OWNER regarding any inspection of manufacturing by the ENGINEER or tests to be performed by an independent testing laboratory. Material, fabricated parts, and pipe, which are discovered to be defective, or which do not conform to the requirements of this Section hall be subject to rejection at any time prior to final acceptance of the product. The requirements of this paragraph do not relieve the manufacturer of the duty to perform all inspection and testing required by this Section or the standards referenced herein.

E. Factory Testing:
   1. The Manufacturer shall perform and provide a written record of all tests required by the applicable AWWA standards and as listed herein.
   2. Shop-applied cement mortar linings shall be tested in accordance with AWWA C205.
   3. The pipe coating shall be tested as specified in Section 09 92 00 Pipeline Coating.
   4. Hydrostatic Pressure Testing:
      a. Each joint of pipe shall be hydrostatically tested prior to application of lining or coating. The internal test pressure shall be that which results in a fiber stress equal to 75 percent of the minimum yield strength of the steel used.

Each joint of pipe tested shall be completely watertight under maximum test pressure. As a part of testing equipment, the pipe Manufacturer shall maintain a calibrated recording pressure gauge, reference number of pipe tested, etc. The pipe shall be numbered in order that this information can be recorded.

b. Fittings shall be fabricated from hydrostatically tested pipe. All manual welds on fittings shall be tested by hydrostatic test, ultrasonic test, air test, or magnetic particle test. Air test shall be made by applying air to the welds at 40 pounds per square inch pressure and checking for leaks around and through welds with a soap solution as described in AWWA C200. In addition, 5 percent of manual welds on fittings shall be checked with x-ray or ultrasonic testing by an independent NDE technician with ASNT SNT-TC-1A Level II.

5. Charpy V-Notch Test: Each heat of steel for plates or coil 0.4375 inches and thicker shall be tested to verify minimum full-size sample impact values of 25 ft-lb at 30 degrees F in accordance with ASTM A370. Minimum Charpy values for sub-size pipe manufacturers shall be as defined in ASTM A370.
6. Elongation: For the tensile test specified in ASTM A370, test specimens with a 2-inch gage length shall show elongations not less than 22 percent for each heat of steel. When test specimens with an 8-inch gage length are used in lieu of those with a 2-inch gage length, the specimens shall show elongation not less than 18 percent for each heat of steel.
7. Mill Certification: Provide mill test certificates for reinforcing steel or wire, steel plate, steel coil, and cement. The Manufacturer shall provide certifications for all tests described in AWWA C200, for all pipe, fittings, and specials.
8. Quality Management Program: Submit Manufacturer's material, equipment, fabrication, coating, lining, storage, transport, and handling Quality Control Program Provide certified calibration reports for all instruments and utilized in the testing and quality control of the materials to be provided in the Work.

F. Manufacturer's Technicians Required for Pipe Installation:

1. During the construction period, the pipe Manufacturer shall furnish the services of a factory trained, qualified, job experienced technician to advise and instruct the CONTRACTOR and ENGINEER as necessary to ensure the proper handling, storage, joint assembly, lining, and coating repair of the pipe. The technician shall advise the CONTRACTOR in pipe laying operations and shall instruct construction personnel in proper joint assembly and joint inspection procedures. The technician shall be on-site full time during the first seven (7) working days of pipe laying. For the purposes of bidding one working day will be 10 hours. Thereafter the technician shall be on sites as requested by the ENGINEER for up to an additional seven (7) 10 hour working days split into no more than two (2) periods of consecutive days.
2. The pipe Manufacturer shall provide services of the coating Manufacturer's qualified representative and a qualified representative from the heat shrink sleeve Manufacturer for a period of not less than 1 week at the beginning of actual pipe laying operations to advise the CONTRACTOR and ENGINEER regarding installation including handling and storage, cleaning and inspecting, coating repairs, field applied coating, heat shrink installation procedures, and general construction methods and how they may affect the pipe coating. The period shall be timed to

coincide with initial joint assembly, coating and inspection.

3. The Manufacturer's representatives shall be required to return if, in the opinion of the ENGINEER, the coating, lining, or the CONTRACTOR's installation procedures do not comply with Contract Document or Manufacturer's requirements.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following with submittals required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
   a. Detailed drawings and data for pipe, fittings, joint types, gaskets, appurtenances, linings, and coatings.
   b. Tabular laying schedules and schematic plan and profile drawings for all steel piping showing full details of piping, valves, hangers, supports, restraints, couplings, accessories, and specials referenced to the stationing of the pipe as shown on the drawings. The schematic shall include the pipe station and invert elevation at all changes in grade or horizontal alignment; and,
      1) Fabrication Information.
      2) Cylinder thickness.
      3) Manufacturing tolerances.
      4) Maximum angular deflection limitations of field joints.
      5) Restrained or unrestrained joint designation.
      6) Closure sections and cut-offs for field length adjustment.
      7) Bulkheads, including details for removal of test bulkheads and repair of lining.
      8) Weld lead outlets and plugs.
   c. Provide detailed layout of the horizontal and vertical alignment.
   d. Written welding procedures for each type of weld and weld position.
   e. Calculations verifying strength of pipe joints within spans between pipe supports for exposed steel pipe on supports.
   f. Calculations verifying design of blind flanges, access manholes, and small diameter branch connections.
   g Calculations for pipe wall thickness, demonstrating compliance with the Contract Documents.
      1) Provide a tabulation of the external earth loading, both initial and future used in the design of each pipe segment.
      2) Provide a tabulation of the external live loading, both during construction and future use in the design of each pipe segment.
      3) Provide design details for both deflection and buckling design and provide design details for vacuum collapse design.
   h. Design calculations shall show methods and processes used to satisfy the pipe and fittings design criteria specified in the Contract Documents. All calculations shall be prepared and signed and sealed by a professional engineer licensed in the State of Texas.
   i. Provide the design details for the minimum wall thickness. Demonstrate how hoop stress was taken into consideration. Demonstrate the impact of this

design on the choice of steel grade for the pipe. Note changes in steel grade and demonstrate the reason for the change in steel grade.

j. Provide design details of joint pressure capacity.

k. Provide design and coordination details for:
   1) Closure joints.
   2) Joints for appurtenances.
   3) Connections to Structures.
   4) Pipe Connections.

l. Provide design details of joint pressure capacity.

m. Provide certification indicating the gasket is designed to comply with the Contract Documents and was designed for use in this application.

n. Provide design details of joints for thermal and pressure elongation.

o. Design of specials and AWWA C208 fittings, including dimensional calculations and wall thickness calculations, in accordance with AWWA C208. Provide the general geometric layout and the detailed layout of each fitting. Provide calculations for the design of outlets, tees, wyes, reducers, plugs, and anchors. Provide details for weld outlets.

p. Provide a detailed, project specific description of the design criteria used, and assumption made in the design of appurtenances. Describe the specific performance requirements used for each. Detail the location of air valves, drain valves, manways, flow meters, sonic leak detection ports, weld lead access ports, test plugs, and temporary drains.

q. Provide a detailed, project specific description of the design criteria used and assumption made in the design of pipe in tunnels. Provide design details for the walls of carrier pipe and joints. Describe the design of the coating system of the carrier pipe, typical rail and skid system, provisions for joint flexibility at tunnels, and details for installation of the pipe in the tunnel.

r. Provide Manufacturer's recommendations for protecting the pipe's coating system.

s. Full details of reinforcement, pressure rating, and dimensions for pipe and fittings.

t. Location of all outlets as required by the CONTRACTOR to install welds.

u. Provisions for thrust restraint provided by the ENGINEER incorporating the limits of each reach of restrained and/or welded joint including tie-ins to existing pipelines.

v. Where welded joints are required, welding requirements, welding procedures, provisions for thermal stress control, and provisions for control of coating damage shall be depicted.

w. Welding Joint Detail:
   1) Lap joints.
   2) Butt Joints.
   3) Butt Strap Joints.
   4) Miter-cut end for alignment conformance.
   5) Deep bell lap joints required for control of temperature stresses.

x. Shop and Field Welding Data:
   1) Show on a weld map the location, type, size, and extent of welds with reference called out for Welding Procedure Specification (WPS) and NDE

numbers in tail of welding symbols in accordance with AWS 2.4.
2) Submit welding terms and definitions in accordance with AWS 3.0..
3) Indicate by welding symbols or sketches, details of welded joints, and preparation of base metal.
4) Distinguish between shop and field welds.
5) Submit welding data together with Shop Drawings as a complete package.

y. Rubber Gasket Joints are not allowed.

z. Flanged Joints:
1) For each flanged connection provide reference standard, dimensional data, bolt hole number, pattern and diameter, bolt diameter and length, and face condition.
2) Gaskets: Technical data sheets itemizing chemical composition, gasket. Manufacturer's recommended assembly stress range (minimum and maximum), and technical and performance information that indicates compliance with this Specification.
3) Bolting: Certified material testing report itemizing chemical composition, yield and ultimate strength, and performance information that indicates compliance with this Specification.

aa. Within 3 days of shipment, the CONTRACTOR/Manufacturer shall submit an affidavit certifying that the pipe, fittings, specials, and other products and materials furnished, comply with the Contract Documents and the applicable requirements of AWWA Standards.

bb. Prior to pipe fabrication, submit Manufacturer's Welding Procedure Specifications per AWWA C200 and ASME BPVC SEC IX or AWS D1.1.

cc. Provide copies of "Release for Manufacture" layout sheets prior to pipe delivery.

2. Product Data:
a. Manufacturer's literature, including materials of construction, dimensions, weights, specifications and other engineering data.

3. Testing Procedures:
a. Quality control, inspection and testing procedures. Obtain ENGINEER's approval prior to performing tests.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Provide a general certificate signed by manufacturer of each product that product conforms to the Contract Documents and applicable standards referenced in this Section.
b. Certified Test Reports shall be provided by the Manufacturer for all tests required by this Section or the standard referenced herein.
c. Certified test reports shall include but are not limited to:
1) Mill certificates, including chemical and physical test results for each heat of steel, Charpy V-notch tests, and elongation tests.
2) A Certified Test Report from the coating manufacturer indicating that the coatings were applied in accordance with manufacturer's requirements

and in accordance with this Section on all pipe, fittings, and joints made in the factory. Test report from coating manufacturer that states application methods comply with the coating manufacturer's application guidelines and requirements

3) Welder Qualifications Records (WQR) in accordance with AWWA C206, ASME BPVC SEC IX or AWS D1.1 for factory or field welders.
4) Certified test reports for factory welds of fittings from a Certified Welding Inspector provided by the pipe Manufacturer.
5) Certified test reports for cement mortar test.
6) Mortar coatings and linings were applied or allowed to cure at temperature above 32 degrees F.
7) Gasket certification in accordance to AWWA C200, shall be provided where bell and spigot gasket joint pipe is specified
8) Copies of all Manufacturer's factory quality control tests, including testing equipment calibration records.
9) Daily welding reports for field welding showing welder and joint welded shall be submitted monthly.
10) Other tests performed by the Manufacturer's Quality Management Program.

b. Certificates of suitability of elastomers used for gaskets with specified service conditions.

2. Manufacturer's Quality Management Program.
3. Procedure Submittals:
   a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Steel pipe and fitting manufacturer and manufacturer of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and submit written verification of mutually selected method.
   b. Prior to start of pipe installation, submit a CONTRACTOR's Quality Control Plan for field welding. Address the following in the plan:
      1) Safety.
      2) Pipe fit-up and cleanliness.
      3) Weld cleanliness.
      4) CONTRACTOR's Inspection to include: pre-weld visual inspection, root pass visual inspection, mid-pass and final pass visual inspections, and documentation.
      5) OWNER's Inspections.

4. Qualifications Statements:
   a. Pipe Manufacturer: When requested by ENGINEER, submit list of existing installations with contact names and telephone numbers for each.
   b. Welders: Submit qualifications for automatic and manual welding operators and procedures to demonstrate conformance to specified qualification requirements.
   c. Weld Inspectors: For each, submit certified weld inspector's QC-1 certification and qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: The Paragraph is applicable to the delivery, storage and handling of steel pipe. For requirements applicable to other pipe materials reference Section 33 05 05 Buried Piping Installation.

B. Packing:

1. The pipe shall be prepared for shipment to afford maximum protection from normal hazards of transportation and allow pipe to reach the Site in an undamaged condition. Pipe damaged in shipment will not be accepted at the Site until it is satisfactorily repaired. Damaged pipe that cannot be field repaired shall be returned to the Manufacturer's facility and properly repaired.
2. Pipe Section shall be handled in accordance with Paragraph 3.1 of this Section. In all instances deliver, handle and store pipe in accordance with the Manufacturer's recommendations to protect coating systems. Upon delivery of the pipe notify the ENGINEER and OWNER's on-site representative so that an inspection can be made.
3. For mortar lined pipe, after the completed pipe and fittings have been removed from the final cure at the manufacturing plant, the pipe lining shall be protected from drying by means of plastic end covers banded to the pipe ends. Covers shall be maintained over the pipe ends at all times until ready to be placed in the trench. Moisture shall be maintained inside the pipe by periodic addition of water as necessary.
3. Pipes shall be carefully supported during shipment and storage. Pipe, fittings, and specials shall be separated so that they do not bear against each other, and the whole load shall be securely fastened to prevent movement in transit. Ship pipe on padded bunks with tie-down straps immediately under/over each stull set. Store pipe on padded skids, sand or dirt berms, tires, or other suitable means to protect the pipe from damage.
4. No less than 4 feet from each end of each length of pipe, fitting, or special and the middle of each pipe joint shall be internally supported and braced with three-leg stulls to maintain a true circular shape. More internal stulls shall be included to protect the pipe, lining, and coating from damage as determined by the pipe Manufacturer or if they will be greater than 15 feet apart. Internal stulls shall consist of timber or steel firmly wedged and secured so that stulls, including shoes, remain in place and in interment contact with the pipe wall during storage, shipment, and installation. Pipe and liner shall be protected from damage from stulls using shaped wood pads or similar devices. Stulls shall not be welded directly to the pipe except at the end of the pipe where the mortar is held back. Pipe shall be rotated so that one stull remains vertical during storage, shipment, and installation. Stulls shall not be removed until the pipe is laid, set to grade, and backfilled.

C. Point of Delivery: Pipe shall be hauled direct from pipe manufacturing plant to the Site and strung along the alignment depicted in the drawings, thus avoiding re-handling of pipe and the possibility of damage thereto. Where fully loaded truck and trailer cannot operate along the alignment, pipe may be unloaded at access points, and brought to the trench side by methods approved by the ENGINEER; however, the CONTRACTOR shall be responsible to ensure that pipe is undamaged at the time of laying.

D. Handling:
   1. Handling of Pipe: To maintain circular shape and prevent distortion, temporarily brace each end of each length of pipe with pipe manufacturer-approved stulling (bracing), where recommended by pipe manufacturer.
   2. Handling of Lined Pipe and Fittings: Lifting devices shall not contact lined surfaces. Use hooks, forks, straps, and other lifting devices only on exterior of pipe and fittings. Pipe and fittings with damaged lining shall be replaced regardless of cause of damage.
   3. Handling of Coated Pipe and Fittings: Hooks, forks, straps, and other lifting devices shall be padded, nylon or rubber-coated and used on exterior of pipe and fittings only in manner that does not damage the coating. If coating is damaged, notify pipe and coating manufacturer to determine if repair of damaged area or re-coating is required. Perform repairs using manufacturer's recommended procedures and materials provided by manufacturer, as accepted by ENGINEER, and in accordance with AWWA standards. Pipe and fittings requiring re-coating shall be removed from the Site and returned to pipe manufacturer's facility. Repaired or re-coated pipe and fittings shall conform to the Contract Documents.

PART 2 – PRODUCTS

2.1 GENERAL

A. General:
   1. Piping systems and components shall conform to the Contract Documents and be suitable for their intended use.
   2. Joint types, linings, and coatings shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and welded joints for buried piping.

B. Conformance with Standards:
   1. Pipe and fittings manufactured shall conform to ASTM and AWWA standards referenced in this Section. Physical tests and chemical analyses shall be performed as required on pipe and fittings being furnished to verify conformance. Tests and analyses shall be

performed by an independent testing agency approved by ENGINEER and paid by CONTRACTOR. Select test samples in conformance with ASTM requirements.

2.2 DETAILED REQUIREMENTS, CARBON STEEL PIPE

A. Materials:
1. Steel shall meet the requirements of AWWA C200 and shall be of continuous casting.
2. Pipe intended for use on potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61-G.
3. Steel proposed for the manufacturing of pipe and fittings shall be as stated in AWWA C200 Table 1 or AWS D1.1 TABLE 3.1, Group I or II.
4. Steel shall be homogeneous and shall be suitable for field welding, fully killed and fine austenitic grain size.
5. Steel shall have minimum yield strength of 42,000 psi.

B. Bends (Fittings):
1. Fabricate fittings from material or straight pipe in full conformance with the requirements of this Section and dimensions of AWWA C208 unless otherwise indicated.
2. Fittings shall have a minimum radius of 2.5 diameters unless otherwise depicted in the drawings. Where a radius of less than 2.5 is required appropriate stress intensification factors shall be used. In no case shall the radius be less than allowed by AWWA C208 limitations on the diameter multiplier. The radius shall at minimum result in a fitting segment length of 1.5-inches or six (6) times the thickness of the pipe cylinder whichever is greater.

C. Service Conditions:
1. Pipe and fittings shall conform to the service conditions in Table 40 05 24.13-A:

TABLE 40 05 24.23-A
STEEL PIPE SERVICE CONDITIONS

Liquid Service	Nominal Diameter (inches)	Max. Flow (GPM)	Internal Design Pressure (psi)	Transient Pressure (psi)	Maximum Operating Temperature (degrees F)	Fluid pH	Specific Gravity
FW	20	10,000	50	75	86	7 – 9	1

2. Nominal diameter of pipe shall not include the thickness of lining or coating.
3. Allowable stress in pipe material shall not exceed 50 percent of material's yield stress. Under transient conditions, increase in hoop stress shall not exceed the smaller of the following: 75 percent of material's yield strength, or full mill test pressure.

4. For buried pipe, unless otherwise specified or indicated on the Drawings, the soil density shall be 120 pounds per cubic foot. Modulus of soil reaction shall be at least 1,000 psi in accordance with AWWA Manual M11. Include in the determination of external pressure, as applicable, AASHTO H-20 truck loading and groundwater hydrostatic loads. Allowable pipe deflection for various lining and coating systems used for external load calculations should be per AWWA Manual M11, with lining types specified in TABLE 40 05 24.23-D, SERVICE CONDITIONS FOR COATINGS.

D. Manufacturer: Provide products of one of the following:
   1. American SpiralWeld Pipe Company.
   2. Northwest Pipe Company.
   3. Thompson Pipe Company
   4. Mid America Pipe.

E. Other manufacturers will not be evaluated, nor substitutes allowed.

F. Design:
   1. For the purpose of pipe design calculations noted in Paragraph 1.4 A. of this Section, working pressure plus transient pressure shall be equal to 1.4 times the pressure class specified or the actual calculated total, whichever is higher. Fittings, specials, and connections shall be designed for the same pressures as the adjacent pipe. Pipe design shall be based on trench conditions using the prism load and the design pressure in accordance with AWWA M11; using the following parameters:
      a. Unit Weight of Fill: 120 pcf.
   b. Deflection Lag Factor - (Dl): 1.0.
   c. Bedding Constant - K: 0.10.
   d. Soil Modulus - (E'):
      1) 1300 psi (Typical Granular Embedment Trench Section).
      2) 3000 psi (Flowable Fill, CLSM, Concrete Encasement Trench Section).
   e. Trench Depth: As shown on the Drawings.
   f. Live Loads:
      1) AASHTO HS 20 at all locations, except railroads.
      2) Coopers E 80 at Railroads.
   g. Maximum Calculated Deflection - DX = DY:
      1) 2 percent (polyurethane coated steel pipe) for all loading conditions except where a future loading condition is specified.
      2) 1 percent (mortar or shotcrete coated pipe where allowed) for all loading conditions including any specified future loading conditions.
   2. The fittings and specials shall be designed in accordance with AWWA C208 and AWWA M11. Crotch plates shall be used for outlet reinforcement for all Pressure Diameter Values (PDV), greater than 6000.

3. Provide alternate methods for pipe embedment if additional external support is required to meet the specified maximum deflection. Trench depths indicated shall be verified after existing utilities are located. Vertical alignment changes required because of existing utility or other conflicts shall be accommodated by an appropriate change in pipe and embedment design depth. In no case shall pipe and embedment system be installed deeper than its design allows.
4. Pipe shall be designed for full vacuum conditions without buckling, damage to lining, or damage to pipe joints.
5. Maximum calculated deflection limit of 3 percent for any of the following future loadings.
   a. The pipe shall be designed to support 8 feet of additional fill on the pipeline above the finished grade.
   b. A fully loaded Link Belt Model 238 Hylab 5 crane (150-ton capacity) or equivalent model. This crane will be parked over the pipeline for 2 days maximum during repair operations. The design shall assume the worst-case scenario for track orientation. For purposes of design, the construction load will be considered a transient load.
6. Provisions for Thrust: all pipe joints shall be restrained.

7. Pipe Wall Thickness: Unless otherwise specified in the piping schedules at the end of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, minimum pipe wall thickness shall be as specified in Table 40 05 24.23-B and manufactured in conformance with the applicable ASTM standards listed in Table 40 05 24.23-B:

TABLE 40 05 24.23-B
STEEL PIPE WALL
THICKNESS

Nominal Diameter	Wall Thickness	Steel Materials
6 to 12 inch	0.250-inch	See Note 1
14 to 24 inch	0.250-inch	See Note 1
30 to 48 inch	0.500-inch	See Note 1

Notes:
[1]Comply with Paragraph 2.2 A of this Section.

8. Exposed (non-buried) pipe which is placed in a building, vault or aerial shall have a minimum pipe wall steel thickness of 0.25 inches or, D/144, whichever is greater.

H. Manufactured (fabricated) Pipe Lengths:
1. Pipe shall be fabricated in minimum lengths of at least 20 feet unless otherwise shown or indicated on the Drawings, or limited by transportation and handling restrictions, including Site conditions.

Do not provide lengths less than 20 feet unless approved by ENGINEER in the Shop Drawings.

2. Maximum joint length shall not exceed 50 feet.

I. Welds:

1. All spiral, longitudinal, and girth seams used in manufacturing pipe shall be full-penetration welded butt-joints.
2. Fabricate pipe with no more than two longitudinal seams.
3. Circumferential welds in straight pipe shall be no closer than seven feet apart.
4. Use girth welds for pipe sections and mitered joints in specials and fittings only when approved by ENGINEER in the steel pipe submittals. Shop-test girth welds for pipe sections and mitered joints in specials and fittings in accordance with AWWA C200.

J. Pipe Ends: Prepare ends of pipe in the shop in conformance with AWWA C200 for the specified joint type. Ends shall be free of notches, weld splatter, and burrs.

K. Cement Mortar Linings: Cement mortar linings for pipe sizes 72 inches and smaller shall be shop-applied.

L. Steel Pipe Joints:

1. Pipe ends shall be lap welded slip joint; butt strap joint; flanged joint, or flexible coupled joint. Pipe shall be welded at all pipe joints unless otherwise specified on the Drawings. Pipe ends shall be suitable for full vacuum and the maximum surge pressures indicated.

2. Shop-welded Joints:
   a. Welded joints shall conform to AWWA C200 and AWWA C206.
   b. Fabricate ends of pipe for the specified type of welded joint.

3. Lap Welded Slip Joint:
   a. Lap welded slip joint shall be provided in all locations for pipe 54 inches and larger, for pressure class greater than 250 psi and where joints are welded for thrust restraint. Ends of pipe, fittings, and specials for field welded joints shall be prepared with one end expanded in order to receive a plain end making a bell and plain end type of joint. Bells formed by rolling will not be allowed unless approved by the Engineer. Clearance between the surfaces of lap joints shall not exceed 1/8 inch at any point around the periphery.
   b. The depth of bell shall be such as to provide for a minimum clear distance of 2 inches between the weld and the nearest tangent of the bell radius when welds are to be located on the inside of the pipe.
   c. The depth of bell shall be such as to provide for a minimum lap of 2 inches. For all welded pipe, provide a deeper bell every 400 feet to accommodate thermal movement, for which the minimum lap shall

be 4 inches.

d. Lap welded slip joints shall be welded from the inside for pipe diameters 48-inch and larger. Lap welded slip joints shall be welded from the outside for diameters smaller than 48 inches.
e. Welds shall be water tight.
f. Double welded lap joints, where specified, and butt strap joints shall be tapped and drilled for testing from the outside in accordance with AWWA C206 and the Drawings.
g. For pipe 30 inches in diameter and larger, precisely paint a circumferential 3/4-inch insertion band (leading edge of band indicating minimum insertion; trailing edge of band indicting maximum insertion; pulled joints to occur within the band around entire circumference) around the outside of spigot end to indicate location at which spigot end has reached required penetration into bell.
h. For welded pipe, deflections up to 3 degrees at a single joint may be used by factory-mitering the bell end of one pipe. The total deflection (including pulled joints) shall not exceed 3 degrees.

4. Butt Strap Closure Joints:
   a. Where necessary to make closure to pipe previously laid, closure joints shall be installed using butt strap joints in accordance with AWWA C206 and applicable provisions of this Section. Thickness of butt strap shall be the thickness of thicker pipe joined.
   b. Butt straps which cannot be field hydrostatically tested shall have an inside and outside weld and shall be air tested as described in AWWA C206. Air test shall be performed from a 1/4-inch NPT threaded fitting between the welds, which shall be seal welded upon successful completion of the testing.

5. Bell and Spigot Joint with Rubber Gasket are not allowed for any pipe diameter or pressure.

6. Mechanical Coupling Joints:
   a. Mechanical coupling joints shall conform to AWWA C200 and AWWA C219.
   b. Fabricate ends of pipe to allow installation of required type of mechanical coupling joint. Exterior surfaces of pipe ends shall be free from surface defects. Longitudinal or spiral welds shall be ground flush with plate or sheet surface for sufficient distance from pipe ends to allow coupling's gaskets to create a watertight seal. Shop-applied coatings shall be held back from pipe ends if required for field assembly. Interior linings shall be continuous to ends of pipe sections.
   c. Mechanical coupling joints shall be restrained unless otherwise shown or indicated in the Contract Documents. Size of harnessing rods shall be sufficient for the greater of the following: specified test pressure, or transient pressure.

d. Conform to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

7. Grooved or Shouldered End Coupling Joints:
   a. Grooved or shouldered end coupling joints shall conform to AWWA C606. Couplings are specified in Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   b. Fabricate ends of pipe to allow installation of the associated grooved or shouldered end coupling joint. Exterior surfaces of pipe ends shall be free from surface defects. Longitudinal or spiral welds shall be ground flush with plate or sheet surface for sufficient distance from pipe ends to allow the coupling's gaskets to create a watertight seal.
8. Flanged Joints:
   a. Flanged joints shall conform to AWWA C200 and AWWA C207.
   b. Exterior surfaces of pipe ends shall be free from surface defects. Longitudinal or spiral welds shall be ground flush with plate or sheet surface for sufficient distance from ends to allow proper installation of flange.
   c. Flanges shall be flat-faced with serrated concentric or spiral finish.

   d. Flanges shall have dimensions conforming to AWWA C207 as specified in Table 40 05 24.23-C:

TABLE 40 05 24.23-C: FLANGES

Service	Flange Type	Pressure Rating (psi)	Flange Class	Pipe Nominal Diameter (inches)
FW	Ring	150	D	30
FW	Ring	150	D	20

   e. Weld flanges to pipe using two fillet welds per flange (inside and out), conforming to method specified in AWWA C207. When method is not practical, welding shall conform to Section VIII, Division I, of the ANSI/ASME Boiler and Pressure Vessel Code. Welding, welders, and welding operators shall be pre-qualified in accordance with AWS D1.1 or ANSI/ASME Boiler and Pressure Vessel Code, Section IX.
   f. For large-diameter flanges with outside diameter exceeding the width of available plate material, use a maximum of four welded segments for flange fabrication. Welding of flange segments shall conform to requirements for welding flanges to pipe. Welds for segmented flanges shall be radiographically or ultrasonically tested in the shop. After welding, segmented flanges shall be stress-relieved in shop.
   g. Flange bolting shall be as follows:
      1) Bolts: Conform to ANSI/ASME B18.2.1.
         a) For Class B and D Flanges: ASTM A307, Grade B.
         b) For Class E and F Flanges: ASTM A193, Grade B7, Heavy hex.

2) Nuts: Conform to ANSI/ASME B18.2.2.
   a) ASTM A194, Grade 2H, Heavy hex.

h. Flange Nuts and Bolts:
   1) Furnish all bolts, nuts, flange gaskets, and insulation kits.
   2) All bolts, and thrust rods inside buildings or vaults shall conform to ASTM A193, Grade B7. Nuts shall conform to ASTM A194, Grade 2H heavy hex nut. Washers shall conform to ASTM A436. Use an anti-seize compound during installation.
   3) All buried bolts shall be Type 316 Stainless Steel conforming to ASTM A193, Grade 8M, and nuts conforming to ASTM A194, Grade 8M. Washers shall conform to ASTM A193. Use an anti-seize compound during installation.
   4) All bolts shall be long enough that a minimum of three threads are exposed beyond the nut.

i. Gaskets for Flanged Joints: Conform to AWWA C207 and the following:
   1) Gaskets for services up to 175 psi working pressure and 200 degrees F shall be red rubber (SBR) with Shore A hardness of 80 plus-or-minus five, with yield pressure of 200 psi (minimum) to 1,200 psi (maximum) in accordance with ASTM D1330, Grades I and II. Use SBR gaskets for the following flange Classes: B, D, and E.
   2) Gaskets for services up to 300 psi working pressure and 250 degrees F shall be non-asbestos type consisting of blend of synthetic fibers, fillers, and elastomeric binders. Gasket yield pressure shall be minimum 3,600 psi for 1/16-inch thickness and minimum 4,800 psi for 1/8-inch thickness, and shall be suitable for maximum seating pressure of 15,000 psi.
   3) Use ring gaskets with flange Classes B and D for flanges on pipe greater than 24-inch diameter, and for flange Classes E and F.
   4) Use full-face gaskets on flange Classes B and D for flanges on pipe up to and including 24-inch diameter.

j. Blind Flanges:
   1) Fabrication: Blind flanges shall be flat-faced and conform to AWWA C207. On pipe larger than 48-inch diameter, provide blind flanges consisting of a combination of a ring flange and a flanged and dished head. Machine face all blind flanges to match the mating flange.
   2) Material: Fabricate blind flanges from ASTM A36 steel plate.
   3) Bolts: For Class B and Class D flanges, use ASTM A307, Grade B bolts. For Class E and Class F flanges, use ASTM A193, Grade B7 bolts.

M. AWWA Steel Pipe Specials and Fittings:
1. Specials and fittings shall be the same material as adjoining pipe. Materials and fabrication methods shall conform to AWWA C200.
2. Dimensions of specials and fittings shall conform to AWWA C208 unless otherwise shown or indicated in the Contract Documents.

3. Radius of fabricated elbows shall be at least 2.5 pipe diameters, unless the wall thickness of elbow section is provided based on formulas included in Chapter 9 of AWWA Manual M11.
4. Length of reducers shall be four times the difference in pipe diameters at each end of reducer. Reducers fabricated to the above dimensional requirement resulting in a half-apex angle of seven to 7.5 degrees or less shall have wall thickness equal to the wall thickness of the larger diameter pipe section connecting to reducer. Fabricate reducers that have half-apex angles greater than eight degrees in accordance with ANSI/ASME Boiler and Pressure Vessel Code, Section VIII, Division I.

N. Access Manway: Provide at locations shown or indicated. Manhole type shall be as shown or indicated on the drawings and shall consist of a 30-inch diameter flanged outlet with blind flange cover. Fabricate covers from carbon steel plate with thickness as required for specified operating conditions and test pressure, with two handles per cover fabricated from one-inch diameter steel rod. At option of CONTRACTOR, subject to approval of ENGINEER, reinforced or dished covers of lighter weight and equal strength material may be provided.

O. Small-diameter Branch Connections:
1. Small diameter branch connections up to 12-inch diameter shall be ANSI/ASME B16.9 fittings. Material of outlet pipe shall conform to ASTM A53, Type E or S, Grade B, and shall be the same material as the main line unless otherwise shown or indicated. Provide branch connections 2.5-inch diameter and smaller by welding on to the main line fittings with threaded outlets. Outlet length shall be one-inch, minimum.
2. Provide branch connections three-inch through 12-inch diameter with pipe nipples or with welding fittings with welded outlets. Pipe nipples and weld fittings shall be welded to pipe shell and reinforced as required to meet specified service conditions and test pressure. Pipe nipples shall be as short as possible.
3. Locate branch connections so that they do not interfere with joints, supports, and other adjacent items. Provide branch connections with caps or plugs to protect threads during shipping, handling, and construction.

P. Threaded Outlets: Where outlets or taps are threaded, furnish and install insulated bushings for the outlet size indicated. Protect and coat threads in accordance with Paragraph 2.4 A. 4. of this Section.

Q. Outlets for Weld Leads: The CONTRACTOR may use outlets for access for weld leads. Outlets shall be welded after use. Outlet configuration shall be as shown on Drawings. The maximum spacing for outlets for weld leads shall be 500 feet unless otherwise approved. Outlets through manways, air valves, and blow offs shall be used for access for weld leads and shall be included in the calculation for 500-foot maximum spacing.

R. Coatings for buried steel Pipe:
1. The CONTRACTOR shall refer to Section 09 92 00 Pipeline Coating.
3. Coatings for exposed steel pipe are as specified in Paragraphs 2.2 U. of this Section.

S. Service Conditions for Linings are specified in Table 40 05 24.13-D.

TABLE 40 05 24.23-D
SERVICE CONDITIONS FOR LININGS

Property	
Fluid(s) Conveyed Through Pipe	FW
pH Range	7 – 9
Temperature Range (degrees F)	37 – 90
Maximum Fluid Velocity (fps)	7
Lining Type	Cement Mortar

T. Linings for Exposed Steel Pipe:
1. General:
   a. Lining types are specified in the piping schedules in and Section 40 05 05, Exposed Piping Installation.
   b. Linings shall be held back at ends of pipe as required for specified joint types.
   c. Surface Preparation: Prepare surface in accordance with manufacturer's recommended method.
2. Cement Mortar Lining: Where specified in piping schedules in Section 40 05 05, Exposed Piping Installation specify mortar lining for exposed pipe service.
3. Liquid Epoxy Lining: Where specified in piping schedules in Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with liquid epoxy lining in accordance with Section 09 91 00 Painting. Utilize internal lining transition sealant between mortar and epoxy Lined Pipe:
   a. Masked off 1–1.5 inches from the edge of mortar to be in contact with the lining transition sealant and round the leading edge to a 1/8-inch radius before application.
   b. Surface preparation for transition sealant shall include mechanically abrading (sanding) the existing epoxy lining and mortar surface. Material shall a be 100% solids, solvent free, Epoxy paste/grout.
   c. Special Requirements for transition sealant include de-glossing and mechanically abrading the area coated prior to application to remove all laitance from mortar surface and subsequently removing dust. Epoxy and mortar area shall be dry prior to application.
   d. Apply lining transition sealant a maximum thickness of 1-inch.

U. Coatings for Exposed Steel Pipe:
   1. General:
      a. Vault or exposed above ground pipe shall be shop primed with the coating system specified in Section 09 91 00 Painting.
      b. Pipe shall be shop primed and coated in accordance with a paint system specified in this Section. Intermediate and finish (color) coats shall be applied in the field.
      c. Where piping color and labeling is specified one to two additional coats shall be applied in addition to the paint coating thickness required by Section 09 91 00. The paint manufacturer shall be responsible for determining compatibility of a color coat that is available in the specified or OWNER selected color.
      d. Coatings for pipe with welded joints shall be held back a minimum of 3 inches from the weld location or as required on the drawings.
      e. Surface Preparation: Prepare surface in accordance with method specified in this Section for the associated coating system.
   2. Piping that is submerged in basins or is located in vaults or structures shall be coated with the specified system for New and Existing Ferrous Metals, Interior Surfaces of Potable Water Storage Reservoirs in Paragraph 2.2 G of Section 09 91 00.
   3. Piping that is located above ground and exposed to the weather shall be with the specified system for New and Existing Ferrous Metals, New and Existing Ferrous Metals in Paragraph 2.2 H of Section 09 91 00. Source quality control for liquid epoxy coatings shall be provided in the shop in accordance with requirements of this Section and AWWA C210.

V. Lining for buried steel pipe: for requirements applicable to buried service the CONTRACTOR shall refer to Section 40 05 24.90 Plant Applied Cement Mortar Ling of Steel Pipe in Water Service based on the size of the pipe and description of work defined therein.

2.3 DETAILED REQUIREMENTS, SMALL-DIAMETER, BUTT-WELDED STEEL PIPE

A. Small Diameter Butt-Welded Steel Pipe and Fittings:
   1. Manufacturer: Provide products of one of the following:
      a. Alaskan Copper.
      b. Or approved equal.
   2. Pipe:
      a. Steel pipe less than six-inch diameter shall be double butt-welded.
      b. Pipe three-inch diameter and smaller shall be ASTM A53, Type F, Grade A.
      c. Pipe four-inch diameter and larger shall be ASTM A53,

Type E or S, Grade B.

d. Minimum wall thickness of pipe shall be Schedule 40.

e. Fabricate ends of pipe for the specified type of butt-welded joint. For galvanized pipe, remove galvanizing from end of pipe prior to welding. Touch-up ends of galvanized pipe with cold galvanizing compound after completion of welding.

f. All welding shall conform to of Section IX Welding Qualifications of the ANSI/ASME Boiler and Pressure Vessel Code and ANSI/ASME B31.3.

3. Fittings:

a. Wrought Fittings (Up to Six-inch Diameter): ASTM A234, Grade WPB, ANSI/ASME B16.9 (bore to match pipe) with butt-weld ends.

4. Flanges (where required for use on butt-welded pipe):

a. Flanges (Up to Six-inch Diameter): ASTM A105, Class 150, ANSI/ASME B16.5, raised face, double welded weld-neck or slip-on (bore to match pipe).

b. Bolts: Conform to ANSI/ASME B18.2.1, ASTM A193, Grade B7. Bolt threads shall be in accordance with ANSI/ASME B1.1 with Class 2A fit.

c. Nuts: Conform to ANSI/ASME B18.2.2, ASTM A194, Grade 2H, heavy hex. Nut threads shall be in accordance with ANSI/ASME B1.1 with Class 2B fit.

d. Gaskets: As recommended by gasket manufacturer for the specified service.

e. Number of flanged joints shall be minimized.

f. Do not use flanges on Type F pipe.

2.4 DETAILED REQUIREMENTS, SMALL-DIAMETER, THREADED STEEL PIPE

A. Small Diameter Threaded Steel Pipe and Fittings:

1. Manufacturer: Provide products of one of the following:

a. Alaskan Copper.

b. Or equal.

2. Pipe and Joints:

a. Fabrication: Steel pipe less than two-inch diameter shall be provided with threaded ends and ASTM A865 threaded line couplings. Threads shall conform to ANSI/ASME B1.20.1. Unless otherwise specified or indicated, provide on all threaded joints Teflon tape or joint sealing compound compatible with specified service.

b. Material: Pipe shall be ASTM A53, Type E or S, Grade B.

c. Wall Thickness: Minimum wall thickness of pipe with threaded ends shall be Schedule 80.

3. Fittings:

a. Threaded fittings shall be either malleable iron, ASTM A197, conforming to ANSI/ASME B16.3; or cast iron,

ASTM A126, Class A, conforming to ANSI/ASME B16.4.

b. Malleable iron fittings shall be Class 150, minimum. Provide Class 300 where required for high-pressure applications.

c. Cast iron fittings shall be Class 125, minimum. Provide Class 250 where required for high-pressure applications.

d. Threads shall conform to ANSI/ASME B1.20.1. Unless otherwise specified, for all threaded joints provide Teflon tape or joint sealing compound compatible with the specified service.

4. Coating: Coat threads of threaded pipe and connections that will be field assembled with rust-inhibiting compound. After field assembly, remove compound and coat exposed areas with liquid epoxy in accordance with same procedures and methods specified for shop-coated pipe and fittings

2.6 IDENTIFICATION

A. All pipeline materials shall be stamped, marked, or identified on interior and exterior with the following:

1. Manufacturer's name or trademark.
2. Pipe class and reference standard designation.
3. Size and length dimensions.
4. Date and place of manufacture.
5. Identification number as shown on the Shop Drawings

B. Each joint of pipe shall marked on the inside of both ends.

C. The identification number shall also be plainly marked on the outside of both pipe ends.

D. Miter-cut pipe shall be marked with the angle of miter-cut and point of maximum miter-cut and the centerline on all specials.

2.7 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Inspections: All pipe and fittings, shop applied linings and coatings, shop welds, and related Work performed in the shop shall be inspected by manufacturer in accordance with applicable reference standards and as specified in this Section. Submit inspection reports to ENGINEER prior to shipment from the shop.

2. Tests: Perform shop tests on the following in conformance with applicable standards referenced in this Section:

a. Pipe:

1) Pressure Test: Test each length of pipe of each diameter and working pressure to the greater of the following test pressures: at least 80 percent of pipe's

yield strength, or according to the pressure testing formula in AWWA C200. Maintain test pressure for minimum of two minutes.

2) Welds: All fillet welds shall be examined using magnetic particle method or dye penetrant method. All welds shall be visually inspected by welding inspector certified by AWS. Welds for segmented flanges shall be radiographically or ultrasonically tested in the shop.

3) Shop Fit Tests: For all pipe with lap joints, and bell or spigot end joints, perform shop fit test on at least five joints of each pipe size and joint type manufactured in each production run.

b. Fittings and Specials: Test each fitting and special using at least one of the following nondestructive testing methods: visual inspection, dye penetrant examination, magnetic particle testing, radiographic testing, or ultrasonic testing.

c. Linings and Coatings:

1) Cement Mortar Lining: Test lining in the shop in accordance with Section 40 05 24.90 Plant Applied Cement Mortar Ling of Steel Pipe in Water Service and AWWA C205.

2) Liquid Epoxy Lining for exposed pipe: Linings shall be shop tested for adhesion in accordance with ASTM D3359 Method A and ASTM D4541, holiday tested in accordance with NACE RP0188, and cure tested in accordance with ASTM D4752 and D3363. Linings shall meet the applicable requirements of AWWA C210.

3) Polyurethane Lining for exposed pipe: Linings shall be shop tested for adhesion by V-cut method, holiday tested in accordance with NACE RP0188, cure tested in accordance with manufacturer's recommended procedure, visually inspected, and dry-film thickness tested in accordance with SSPC-PA 2, and shall meet applicable requirements of AWWA C222.

4) Coating of buried pipe: Coating shall be shop tested in accordance with Section 09 92 00 Pipeline Coating.

PART 3 – EXECUTION

3.1 INSTALLATION

A. For exposed piping installation, refer to Section 40 05 05, Exposed

Piping Installation.

B. General requirement for installation of buried piping are noted in Section 33 05 05 Buried Piping Installation. Field-welded joints shall conform to requirements for shop-welded joints specified in this Section.

C. Additional requirements specific to the installation of steel piping are provided below. Where differences in execution specified in Section 33 05 05 are noted the following requirements shall govern:
   1. Install steel pipe, fittings, specials, and appurtenances as specified and required for the proper functioning of the completed pipeline. Install pipe, fittings, and specials in accordance with the Manufacturer's recommendations and AWWA M11 and AWWA C604. Before each joint of steel pipe is lowered into the ditch, the coating is to be inspected and tested for holidays. All damaged areas and holidays are to be repaired before the pipe is lowered into the trench.
   2. The requirements of Section 31 23 05 Excavation and Fill govern for the excavation and backfilling of trenches for laying steel pipe, fittings, and specials. Conformance with pipe deflection requirements shall be as set forth below.
      a. Average allowable pipe deflection is limited to 2 percent for polyurethane coated-steel pipe. In no case shall a single measurement in any direction exceed 1.5 times the average allowable deflection. These measurements include the allowable tolerance for lining thickness. Percent deflection shall be calculated as:

Percent Deflection = (actual (plan) ID - installed (measured) ID) / (actual (plan) ID) ×100

      b. Deflection measurements shall be made by the CONTRACTOR in the presence of the ENGINEER. Method for taking measurements shall be agreed to by the OWNER in writing prior to installing the first joint of pipe.
         1) A demonstration section shall be provided on the first three pipe joints for deflection. Demonstration section shall be completely embedded, backfilled and joints welded and stulls removed.
         2) The CONTRACTOR shall measure deflection approximately 7 days after backfill to final grade or removal of stulls (bracing) whichever occurs later.
         3) The ENGINEER may at its discretion perform additional verification measurements on any area prior to Substantial Completion.
      c. Average deflection shall be determined by averaging the pipe's measured vertical deflection as indicated below. Locations where measurements are taken shall be clearly marked on the interior of the pipe.

1) For pipe joints 36 feet in length or less, measurements shall be taken at two locations, 1/4-distance from each pipe end.
2) For pipe joints longer than 36 feet, measurements shall be taken at three locations including 1/4-distance from each pipe end and at the pipe midpoint.

d. If the average calculated deflection of any pipe segment or any single measurement fails to meet specifications, the entire segment of pipe shall be reworked in accordance with the Manufacturer's recommendations and as directed by the ENGINEER at no additional cost. This may include uncovering the pipe and re-compaction of the pipe embedment, and repair of coating. A pipe segment shall be defined as a length of manufactured pipe between manufactured or field constructed joints.
e. Installed pipe joints will also be examined for flat spots and internal lining stress cracks by the ENGINEER. Repair of flat spots may include uncovering the pipe and re-compaction of the pipe embedment, and repair of the coating.
f. Where pipe has been reworked to comply with the deflection requirements, CONTRACTOR shall re-measure for deflection no earlier than 7 days after the repaired pipe is backfilled. ENGINEER will re-inspect for flat spots at this time.
g. No pipe installation shall be accepted until the entire installation is in compliance with the above deflection requirements.
h. All costs associated with measuring for pipe deflection and any repairs or rework associated with meeting these requirements shall be borne by the CONTRACTOR.
i. Payment for installed pipe will not be made unless the pipe has been measured for deflections.

4. Keep the pipe clean during the laying operation and free of sticks, dirt, animals, and trash, and at the close of each operating day, effectively seal the open end of the pipe against the entrance of water using a gasketed night cap. Do not lay pipe in water. The CONTRACTOR shall install backfill on top of the pipe at night and cap to prevent flotation of the pipe in the event of heavy rain during the night.
5. Install bonds at all pipe joints, other than welded joints or insulated joints.

D. Line, Grade and Cover Over Top of Pipe:
1. Use survey equipment to indicate alignment and grade. For pipe sizes over 54-inches take at least one elevation reading on each length of pipe and at each valve, fitting or appurtenance. Record and report the elevation data as record information.
2. For sizes at or below 54-inch pipe make periodic top of pipe elevation measurements with surveying instruments to verify accuracy of grades.

Take a top of pipe elevation reading at each valve, fitting or appurtenance. Record and report the elevation data collected as record information.

3. Verify survey set up at least daily using an independent benchmark or temporary benchmark.

E. Pipe Handling: Pipe shall be handled at all times with a minimum of two wide non-abrasive slings or belts to prevent damage to the coating or lining. The equipment shall be kept in such repair that its continued use is not injurious to the coating. All pipe shall be handled with a spreader bar. The spacing of pipe supports required to handle the pipe shall be adequate to prevent cracking or damage to the lining or coating. Repair of any damaged coating shall be in accordance with Section 09 92 00 Pipeline Coating.

F. Line Up and Bends:

1. Line up pipe for joining so as to prevent damage thereto. Thoroughly clean the bell and spigot ends of each joint of pipe of foreign matter, rust, and scale before placing spigot into bell. Welded joints shall have an overlap of 2 inches minimum to 4 inches maximum after all alignment adjustments.
2. All under-stabbed joints shall be butt strapped or re-stabbed. All over-stabbed joints shall be re-stabbed, butt strapped, or outside welded.
3. Where abrupt changes in grade and direction occur, the CONTRACTOR shall employ special shop fabricated fittings for the purpose. Field cutting the ends of the steel pipe to accomplish angular changes in grade or direction of the line shall not be permitted.

G. Pipe Laying - Welded Joints:

1. Weld joints in accordance with the AWWA C206 for Field Welding of Steel Water Pipe. CONTRACTOR shall provide adequate ventilation for welders and for ENGINEER to observe welds. Unless otherwise specified, welds shall be full circle fillet welds. Exterior joint welding shall be completed before application of field applied joint coating for pipe 42-inch and smaller. It will be acceptable to weld the pipe joints from the inside after the exterior joint coating and backfilling has been performed for pipe 48-inch and larger, if it can be demonstrated that this procedure will not damage the exterior joint coating.
2. A Welding Procedure Qualification shall be approved by the Engineer before welding of joints begins. The procedure shall be in accordance with AWWA C206 and AWS D1.1.
3. All pipe shall be provided with a deeper bell every 400 feet to accommodate thermal movement, for which the minimum lap shall be 4 inches.
4. Adequate provisions for reducing temperature stresses shall be the responsibility of the Contractor.
5. After the pipe has been joined and properly aligned and prior to the start of the welding procedure, the spigot and bell shall be

made essentially concentric by shimming to obtain a 1/8-inch maximum clearance tolerance around the periphery of the joint. In no case shall the clearance tolerance be permitted to accumulate.

7. Furnish labor, equipment, tools, and supplies to construct the Work as required in the Contract Documents. Protect welding electrodes from moisture and any other deleterious materials in accordance with AWWA C206 and the electrode Manufacturer's requirements. If an electrode hermetic seal is damaged, reject the entire box or carton.
8. In all hand welding, the metal shall be deposited in successive layers. For hand welds, not more than 1/8-inch of metal shall be deposited in each pass. Each pass except the final one, whether in butt or fillet welds, shall be thoroughly bobbed or peened as necessary to relieve shrinkage stresses and to remove slag, dirt, or flux before the succeeding bead is applied. Each pass shall be thoroughly fused into the plates at each side of the welding groove or fillet and shall not be permitted to pile up in the center of the weld. Undercutting along the side shall not be permitted.
9. Welds shall be free from pin holes, non-metallic inclusions, air pockets, undercutting and/or any other defects disallowed by AWWA C206 and AWS D1.1, Table 6.1.
10. If the ends of the pipe are laminated, split, or damaged to the extent that satisfactory welding contact cannot be obtained, the pipe will be replaced at no additional cost to the OWNER and the defective joint removed from the Site.
11. Furnish each welder employed with a steel stencil for marking the welds, so that the work of each welder may be identified. Have each welder stencil the pipe adjacent to the weld with the stencil assigned to him. In the event any welder leaves the job, that welder's stencil shall be voided and not duplicated if another welder is employed.
12. Keep daily welding reports which identify the welder's name and the specific pipe joint(s) welded. Joints must be shown on the daily welding reports with the identification number assigned in the lay drawings (ex. ID#1 – ID#2).
13. Use only competent, skilled and qualified workmen. Each welder employed by the CONTRACTOR shall be qualified in accordance with Paragraph 1.3 A. 2. b. of this Section.
14. Inspections shall be performed on welds produced by each welder qualified above. Any welder making defective welds shall not be allowed to continue to weld.
15. Visual tests and magnetic particle tests in accordance with AWWA C206, ASTM E709, and ASTM E1444, shall be performed by a third-party independent testing laboratory under the direction of the ENGINEER on all field welded joints.

Unless otherwise provide by the Contract Documents the third-party testing laboratory shall be jointly selected by the CONTRACTOR and the OWNER based on qualifications and services shall be performed at the CONTRACTOR's expense. A Certified Weld Inspector shall perform a visual inspection of all welds in accordance with AWWA C206. All root passes shall be inspected by the prior to adding any successive weld layers. Final inspection of fully completed weldments shall be inspected prior to application of overlying coating or lining. Welds that prove to be defective will be replaced or repaired, whichever is deemed necessary by the ENGINEER, and all required work shall be performed at expense of the CONTRACTOR.

16. If the CONTRACTOR disagrees with the Engineer's interpretation of welding tests, test sections may be cut from the joint for physical testing. The CONTRACTOR shall bear the expense of repairing the joint, regardless of the results of physical testing. The procedure for repairing the joint shall be approved by the ENGINEER before proceeding.
17. Test double-welded butt strap joints using the compressed air and soap method per AWWA C206. Following successful completion of the test, seal weld the threaded test fitting.
18. Weld defects such as Excessive Overlaps, Weld Convexity/Concavity, Excessive Weld Reinforcement, Weld Craters, Undersize Welds, Undercutting, Incomplete Fusion, Weld Porosity/Pinholes, Slag Inclusions, and Cracks shall be repaired as follows:
    a. Overlaps, Excessive Convexity, Excessive Reinforcement - shall be repaired by weld metal removal using grinding or gouging/grinding without nicking or gouging adjacent base metal.
    b. Excessive Concavity of Welds or Craters, Undersize Welds, Undercutting - shall be repaired by preparing the weld/base metal surface using grinding, wire brushing, or gouging/grinding without nicking or gouging adjacent base metal followed by the addition of deposited weld metal with the submitted and approved weld procedure.
    c. Incomplete Fusion, Weld Porosity or Pinholes, Slag Inclusions - shall be removed completely using grinding or gouging/grinding methods followed by rewelding with the submitted and approved weld procedure.
    d. Cracks in Weld or Base Metal - shall be repaired by ascertaining the extent of the defect by use of acid etching, MT, PT, or other equally positive means; the crack and sound metal a minimum of 2-inches beyond each end of the crack shall be removed and then rewelded with the submitted and approved weld procedure.
    e. All repairs shall be visually examined, and MT or PT tested

for approval by the designated welding inspector.

H. Flanged Joints: Before the joint is assembled, thoroughly clean the flange faces of Foreign material. Center the gasket in the connecting flanges and draw up watertight without unnecessarily stressing the flanges. Tighten bolts in a progressive diametrically opposite sequence per AWWA C604 Appendix A. Bolts shall be torqued with a suitable, approved and calibrated torque wrench to the torque values as recommended by the pipe Manufacturer. Apply clamping torque to the nuts only. Perform a check pass torqueing bolts to 100-percent of recommended torque value. Check pass shall be performed no sooner than 12 hours after initial assembly and tightening.

I. Inside Joint Grouting for Pipe with Plant-Applied Mortar Lining: Upon completion of backfilling of the pipe trench, and after inspection of interior welds, fill the inside joint recess with a stiff cement mortar. Prior to placing of mortar, clean out dirt or trash which has collected in the joint, and moisten the concrete surfaces of the joint space by spraying or brushing with a wet brush. Where the mortar joint opening is 3 inches or wider, such as where thermal expansion joints are required, apply a bonding agent to mortar and steel surface prior to placing joint mortar. Ram or pack the stiff mortar into the joint space and take extreme care to ensure that no voids remain in the joint space. After the joint has been filled, level the surfaces of the joint mortar with the interior surfaces of the pipe with a steel trowel so that the surface is smooth.

J. Protective Coating System for Welded Joints: Perform field coating of joints in accordance with Section 09 92 00 Pipeline Coating.

K. Protection of Buried Metal: Bolts, flanges, and other buried uncoated ferrous metal which cannot be protected per the Drawings with factory or field-applied polyurethane coatings or heat shrink sleeves shall be coated with two wraps of wax tape meeting AWWA C217 and encased in flowable fill.

L. Quality Control of Field Applied Coating: See Section 09 92 00 Pipeline Coating.

M. Piping Through Vaults: Where piping is to be inside a vault, such as meters or valves, the vault floor shall be cast, then the piping installed, then the vault walls constructed.

N. Hydrostatic Test: Perform a hydrostatic test in accordance with Section 33 05 05 Buried Piping Installation Paragraph 3.5 C and Section 40 05 05 Exposed Piping Installation Table 40 05 05-A.

+ + END OF SECTION + +

40 05 53 PROCESS VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves, four-inch diameter and larger, and appurtenances, complete and operational.
   2. Valves for digester gas and air have been specifically identified. All other valves are for liquid service.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 09 91 00, Painting.
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 05, Exposed Piping Installation.

D. The following index of this Section is included for convenience:

3.3 Field Quality Control
3.4 Supplements

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
1. American Bearing Manufacturers Association (ABMA).
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
4. ANSI/NSF 61 Drinking Water Components – Health Effects.
5. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
6. API STD 598, Valve Inspection and Testing.
7. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
8. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
9. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
10. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
11. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
12. ASTM A276, Specification for Stainless Steel Bars and Shapes.
13. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
14. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
15. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
16. ASTM A536, Specification for Ductile Iron Castings.
17. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
18. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
21. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
22. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
24. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
25. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.
26. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
27. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
28. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
29. AWWA C501, Cast-Iron Sluice Gates.
30. AWWA C502, Dry-Barrel Fire Hydrants.
31. AWWA C504, Rubber-Seated Butterfly Valves.
32. AWWA C507, Ball Valves, 6-inch through 48-inch.
33. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
34. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service.
35. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.

36. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
37. AWWA Manual M49, Butterfly Valves: Torque, Head Loss, and Cavitation Analysis.
38. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
39. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
   2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
   3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
      b. Controls for and control characteristics of modulating valves.
      c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
      d. Calculations for sizing of electric actuators.
      e. Calculations for sizing of operating mechanism with extension stems.
      f. Calculations for sizing of gear actuators.
   2. Product Data:
      a. Product data sheets.
      b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
      c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
      d. Cv values and hydraulic headloss curves.

3. Testing Plans:
    a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
2. Manufacturer Instructions:
    a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
4. Source Quality Control Submittals:
    a. Submit copies of shop test results and inspection data, certified by manufacturer.
5. Field Quality Control Submittals:
    a. Submit results of field tests required.
6. Supplier's Reports:
    a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
7. Qualifications Statements:
    a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
    a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
    b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.

D. Maintenance Material Submittals: Submit the following:
1. Spare Parts, Extra Stock Materials, and Tools:
    a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
    b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.

2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
3. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valves, General:
1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
a. Valve size.
b. Pressure and temperature ratings.
c. Application (other than water and wastewater).
d. Date of manufacture.
e. Manufacturer's name.
3. Provide valves to turn clockwise to close, unless otherwise specified.
4. Provide valves with permanent markings for direction to open.
5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:
1. Valve materials shall be suitable for the associated valve's service or application, as shown.
2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
3. All valves shall be ANSI/NSF 61 certified.
4. Clean and descale fabricated stainless-steel items in accordance with ASTM A380 and the following:
a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent

hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.

b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:

1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 BUTTERFLY VALVES

A. Manufacturers: Provide products of one of the following:

1. DeZurik.
2. Valmatic
3. Crispin

B. General:

1. Provide butterfly valves conforming to AWWA C504 and as specified herein.
2. Sizes:
   a. Flanged: Four-inch through 72-inch diameter.
   b. Mechanical Joint: Four-inch through 48-inch diameter.
3. Rated Working Pressure: 150 psig, Class 150B.
4. Maximum Fluid Temperature: 150 degrees F.
5. Valves shall provide drip-tight bi-directional shutoff at rated pressures.
6. Mount valve seats in valve body. Rubber seats for 24-inch diameter and larger valves shall be replaceable in the field.
7. Valves shall be capable of being maintained in open or partially open position for manual operation, and for automatic operation. When valve disc is maintained, there shall be no chatter or vibration of disc or operating mechanism.
8. Valve packing shall be replaceable without dismantling valve.
9. Disc shall be offset from shaft to provide uninterrupted 360-degree seat seal.

C. Materials of Construction: materials of construction shall conform to AWWA C504 and shall be as follows:

1. Body: Cast-iron, ductile iron, or alloy cast-iron.
2. Shaft: Type 316 stainless steel.
3. Discs:
   a. Valves Smaller than 30-inch Diameter: Cast-iron.

b. Valves 30-inch Diameter and Larger: Ductile iron.

4. Seats: Buna-N or other synthetic rubber suitable for the application.
5. Seating Surfaces: Type 316 stainless steel.
6. Bearings:
   a. Valves Smaller than 24-inch Diameter: Nylon.
   b. Valves 24-inch Diameter and Larger: Fiberglass with Teflon lining.
7. Shaft Seals: Externally adjustable, material same as for seats. For services that are either buried or submerged, self-adjusting V-type chevron, material same as for seats.
8. Tapered Pins for Attachment of Shaft to Disc: Type 316 stainless steel.
9. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.

D. Interior Coating:
   1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.

E. Testing:
   1. Test each valve in the manufacturer's shop in accordance with AWWA C504.

F. Gear Actuators for Manual Valves:
   1. Provide gear actuators conforming to AWWA C540.
   2. Gear actuators for valves 20-inch diameter and smaller shall be constructed for 150 psi differential pressure and 16 feet per second port velocity.
   3. Gear actuators for valves 24-inch diameter and larger shall be constructed for maximum differential pressures and velocities as specified below:
      a. Valve Size and Location: 16-inch, West High Service Pump Station
      b. Maximum Differential Pressure Across Closed Valve: 175 psi
      c. Maximum Port Velocity through Full Open Valve: 8 ft/sec

2.3 SWING FLAP CHECK VALVES

A. Manufacturers: Provide products of one of the following:
   1. APCO Willamette Valve & Primer Corp.
   2. Valmatic
   3. Crispin

B. General:
   1. Provide valves conforming to AWWA C508 and as specified herein.
   2. Type: Rubber Swing Flap (Non-Slam)
   3. Rated Working Pressure: 150 psi
   4. Provide valves suitable for horizontal mounting.
   6. Valve shall be of the full body flanged type, with top access cover, and have a clear waterway with full-open area equal to nominal pipe size.
   7. Disc shall be of one-piece construction, precision molded with an integral O-ring seating edge. Disc shall be removable from the valve without removing the valve from the pipeline. A 25-year warranty shall be provided for the flex portion of the disc.

8. Seating surface shall be on a 45-degree angle to minimize disc travel. Non-slam closure shall be provided through a 35-degree disc stroke from full open to full close, and a mechanically adjustable disc accelerator.
9. The disc accelerator shall be of one-piece construction and provide rapid closure of the valve in high head applications. It shall be enclosed within the valve and shall be adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place captured between the cover and the disc. It shall be formed with a large radius to allow smooth movement over the disc surface.
10. Provide a certified headloss curve for the full flow range of each size valve specified. Valve headloss shall not exceed the following:
    a. 7 inches w.c. at 5 MGD through a 16-inch valve
11. Valve shall be provided with an external disc position indicator.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
1. Body and Cover: Ductile Iron ASTM A536.
2. Disc: Buna-N (minimum of 70 Durometer) internally reinforced with steel.
3. Internal and external bolting and other hardware: Type 316 stainless steel.

D. Interior Coating:
1. Valve interior shall be coated with a fusion bonded epoxy coating that is in accordance with AWWA C550.

E. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C508.
2. Allowable Leakage at Rated Pressure: Zero.

2.4 AIR VALVES

A. Definitions:
1. Air Valve: Valve of one of the following types: Air Release Valve, Air/Vacuum Valve, or Combination Air Valve.
2. Air Release Valve: A hydromechanical device designed to automatically release to atmosphere small pockets of air as they accumulate in a pipeline when pipeline system is full and operating under pressure.
3. Air/Vacuum Valve: Direct-acting, float-operated, hydromechanical device designed to automatically release or admit large volumes of air during filling or draining of a pipeline or piping system. Valve will open to relieve negative pressures and will not reopen to vent air when system is full and under pressure.
4. Combination Air Valve: Device having features of an Air Release Valve and Air/Vacuum Valve.
5. Maximum and Minimum Working Pressure: Pressure range at which valve is designed to function.
6. Orifice: Opening in valve mechanism through which air is expelled from or admitted into pipeline or piping system.
7. Valve Design Pressure: Maximum pressure to which a valve may be subjected without exceeding allowable stress of its components.

B. General:
   1. Extent:
      a. Provide valves included in this Section, per the schedule included in this Section and as shown on the Drawings. Refer to Section 2.16 for air valves for chlorine application services.
   2. Requirements:
      a. Valve Design Pressure: Unless otherwise specified, Valve Design Pressure shall be equal to or exceed design pressure of pipe or equipment on which the valve is installed.
      b. Valve Type, Service, Inlet Size, Orifice Size, Accessories, and Required Features: Provide per the schedule in this Section.
      c. Materials: Air Valve materials shall be suitable for long-term use in the service specified.
      d. Ends:
         1). Provide per the schedule in this Section.
         2). Comply with valve connection requirements in Section 4.3 of ANSI/AWWA C512.
      e. Operating Pressure Range: Valves shall be suitable for an operating pressure range of 0 – 90 psi. Valve Design Pressure shall be greater than the valve's Maximum and Minimum Working Pressure.
      f. Air Valves in water service shall comply with ANSI/AWWA C512 unless otherwise shown or specified.

   3. Markings:
      a. Mark valves per Section 6.1 of ANSI/AWWA C512.

C. Manufacturers: Provide products of one of the following:
   1. APCO, as manufactured by Valve and Primer Corporation.
   2. Crispin, as manufactured by Multiplex Manufacturing Company.
   3. Valmatic
   4. GA Industries

D. Accessories
   1. Isolating Valves:
      a. Provide isolating valves in the schedule included in this Section and as shown. Isolating valves shall conform to applicable requirements of Sections 40 05 53, Process Valves.
      b. Valve Design Pressure of isolating valve shall equal or exceed Valve Design Pressure of the connected Air Valve.
   2. Anti-Slam Devices:
      a. Provide anti-slam devices on inlet to air/vacuum valves and combination air valves where indicated.
      b. Pressure rating of anti-slam device shall equal or exceed Valve Design Pressure of connected Air Valve.
      c. Ends shall be as required for connecting to Air Valve.

d. Anti-slam devices shall be as normally furnished by specified Air Valve manufacturers and be cast iron or ductile iron with bronze or stainless-steel disc and trim.

E. Interior Surfaces Painting:
1. Extent: Paint ferrous surfaces except stainless steel surfaces.
2. Paint: Paint shall be as normally provided by Air Valve manufacturer for the specified application, except for potable water service valves which shall be coated with paint complying with ANSI/AWWA C550 and ANSI/NSF-61.

F. Exterior Surfaces Painting:
1. Exterior surfaces of cast-iron, ductile iron, and steel other than stainless steel, except machined surfaces of valves and appurtenances, shall be finish painted.
2. Surface preparation, painting, and field touch-up painting shall be per Section 09 91 00, Painting.
3. Furnish valve with only a prime coat if so indicated.

G. Source Quality Control:
1. Test and inspect Air Valves per Section 5 of ANSI/AWWA C512. Do not ship valves that are not successfully tested.

2.5 ELECTRIC ACTUATORS (OPEN/CLOSE)

A. Manufacturers: Provide products of one of the following:
1. Rotork
2. EIM
3. Rexa
3. Or equal.

B. Application Criteria:
1. Ambient Temperature Rating: -20 to +158 degrees F.
2. Ambient Humidity: 100 percent.
3. Maximum Differential Pressures Across Closed Valves: Refer to Schedule of Valves with Electric Actuators at the end of this Section.
4. Maximum Flows Through Full-Open Valves: Refer to Schedule of Valves with Electric Actuators located at end of this Section.
5. Power Supply: 480-volt, three-phase, 60 Hertz.
6. Control Voltage: 120 VAC, single phase, 60 Hertz.
7. Torques: As determined by valve manufacturer.
8. Duty Cycle: Sixty starts per hour, minimum.

C. General:
1. Conform to AWWA C540 and this Section.
2. Provide actuator operable with handwheel or chainwheel, even after disengaging and removing electric motor.
3. Provide valves with electric actuators that are located more than five feet above operating floor with separate control panels installed so that panel controls and indicators are approximately five feet above operating floor, at location approved

by ENGINEER. Modify electrical wiring as required for remote location of control panels.

4. Coordinate sizing of each electric actuator with valve manufacturer, who shall furnish valve and associated electric actuator and appurtenances as a unit.
5. Electric actuators shall be suitable for valve orientation as shown.

D. Electric Motor:
   1. General:
      a. Provide motors suitable for "open/close" service, with high torque characteristics and minimum 70 degree C temperature rating.
   2. Motor Construction:
      a. Enclosure: NEMA 6.
      b. Insulation: Class F.
      c. Service Factor: 1.15.
      d. Power Supply: 480-volt, three-phase, 60 Hertz.
      e. Motor Size: As required.
      f. RPM: As required.
      g. Provide winding thermostats for overcurrent protection.
      h. Efficiency: High-efficiency conforming to NEMA MG 1.
      i. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:
   1. Housing: Die-cast aluminum or cast-iron.
   2. Close-coupled to electric motor.
   3. Input Shaft Gearing: Spur or bevel gear assembly.
   4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
   5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
   6. Lubrication: Grease or oil bath.
   7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
   8. Input Shaft: Hardened alloy steel.
   9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:
   1. Provide each actuator with "end of travel" limit switches to allow control of desired end position for each direction of travel.
   2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
   3. Limit switch gearing shall be appropriately lubricated.
   4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.

5. Provide each limit switch with four auxiliary contacts. Two contacts shall close and two contacts shall open at a desired end position for each direction of travel.
6. Switches shall be rated five amperes at 120 volts.

G. Torque Switches:
1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.
3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.
4. Provide dry contacts (five-amp, 120 VAC) for remote high torque alarm.

H. Handwheel and Chainwheel Operation:
1. Provide actuator with handwheel (or chainwheel as required) for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
2. Should electric power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
4. Handwheel or chainwheel shall have an arrow and the word “OPEN” or “CLOSE” indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators:
   a. Valves more than five feet above operating floor level shall be equipped with chain operators.
6. Handwheels and chain operators shall be as specified in Article 2.6 of this Section.

I. Controls:
1. Provide the following controls in separate compartment integral with actuator.
2. Enclosure: NEMA 6.
3. Starter: Combination reversing magnetic starter with circuit breaker and disconnect switch.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide “LOCAL/OFF/REMOTE” selector switch. In “LOCAL” position actuator shall be operated by “OPEN/CLOSE/STOP” pushbuttons. In “OFF” position, actuator shall be disabled from local and remote operation. In “REMOTE” position, “open/close/stop” control from remote source shall be enabled.
6. Provide “OPEN/CLOSE/STOP” pushbuttons with hold-to-run or momentary contact selection.
7. Provide “OPEN/CLOSE/STOP” indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Provide thermal overload and single-phasing protection of motor.

9. Provide set of dry contacts to remotely indicate that actuator is available for remote operation.
10. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
11. Provide electrical interlocks as shown.
12. Provide 120 VAC space heater to maintain internal housing temperature at 20 degrees C.

J. Remote-mounted Control Stations:
1. Where required by valve location or as indicated, provide remote control panels.
2. Enclosure: NEMA 4X, Type 316 stainless steel.
3. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled Provide contact when switch is in "REMOTE" position for remote indication.
4. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
5. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication with liquid crystal display.

K. Testing:
1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.6 APPURTENANCES FOR EXPOSED METALLIC VALVES

A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
2. For valves located five feet or more above operating floor, provide chain operators.
3. Where indicated, provide extension stems and floorstands.

B. Handwheels:
1. Conform to applicable AWWA standards.
2. Material of Construction: Ductile iron, or cast aluminum.
3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
4. Maximum Handwheel Diameter: 2.5 feet.

C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
3. Materials of Construction:
   a. Chain: Type 316L stainless steel.
   b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
   c. Guards and Guides: Type 316L stainless steel.

4. Chain Construction:
    a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
5. Provide geared operators where required to position chainwheels in vertical position.

D. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.
2. Maximum Radius of Crank: 15 inches.
3. Materials:
    a. Crank: Cast-iron or ductile iron.
    b. Handle: Type 304 stainless steel.
    c. Hardware: Type 304 stainless steel.

E. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.7 ANCHORAGES AND MOUNTING HARDWARE

A. General:
1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.8 TOOLS, LUBRICANTS, AND SPARE PARTS

A. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.

B. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.9 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface

preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install valves and appurtenances in accordance with:
      a. Supplier's instructions and the Contract Documents.
      b. Requirements of applicable AWWA standards.
      c. Applicable requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
   3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.

B. Exposed Valves:
   1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
   2. Operators:
      a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
      b. Avoid placing operators at angles to floors or walls.
      c. Orient chain operators out of way of walking areas.
      d. Install valves so that indicator arrows are visible from floor level.
      e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
   3. Floor Stands and Stems:
      a. Install floor stands as shown and as recommended by manufacturer.
      b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
      c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.

C. Buried Valves:

1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
2. Provide flexible coupling next to each buried valve.

D. Plug Valves:
1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
1. Adjust all parts and components as required to provide correct operation of valves.
2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
3. Verify satisfactory operation and controls of motor operated valves.
4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

B. Supplier's Services:
1. Provide services of qualified factory-trained service technicians to check and approve installation of the valves.
2. Supplier's serviceman shall perform the following:
a. Supervise unloading of the equipment.
b. Instruct CONTRACTOR in installing equipment.
c. Supervise installation of equipment.
d. Inspect and adjust equipment after installation and ensure proper operation.
e. Instruct OWNER's personnel in operating and maintaining the equipment.
3. Manufacturer's representative shall make a minimum of two (2) visits, with a minimum of four (4) hours onsite for each visit. First visit shall be for unloading supervision (if specified) and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
4. Training: Furnish services of Supplier's qualified factory trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 SCHEDULE OF VALVES

A. The schedule of valves is shown in Table 40 05 53-A, Schedule of Valves.

TABLE 40 05 53-A, SCHEDULE OF VALVES

Valve Tag	Type	Service	Valve Size (in)	Operator (Man., Elec., Pneu.)	Maximum Normal Flow Through Valve	Actuator (O/C or Mod.)	Open/Close Valve Travel Time	Specification Paragraph
JK-WHS-VL12	CV	FW	16	Manual	5 mgd	-	-	2.3
JK-WHS-VL13	CV	FW	16	Manual	5 mgd	-	-	2.3
JK-WHS-VL14	BV	FW	16	Electric	5 mgd	O/C	15 sec	2.2
JK-WHS-VL15	BV	FW	16	Electric	5 mgd	O/C	15 sec	2.2
JK-WHS-VL16	BV	FW	16	Manual	5 mgd	-	-	2.3
JK-WHS-VL17	BV	FW	16	Manual	5 mgd	-	-	2.3
JK-WHS-VL18	BV	FW	20	Manual	5 mgd	-	-	2.3
JK-WHS-VL19	BV	FW	20	Manual	5 mgd	-	-	2.3

Abbreviations and Notes:
CV: Check Valve
BV: Butterfly Valve
FW: Finished Water

+ + END OF SECTION + +

40 05 93 COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as specified and required to furnish and install electric motors complete and operational.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. IEEE 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   3. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
   4. IEEE 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
   5. IEEE 522 - Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating Current Electric Machines.
   6. IEEE 1043, Recommended Practice for Voltage Endurance Testing of Form-Wound Bars and Coils.
   7. NEMA MG-1 - Motors and Generators.
   8. NEMA MG-2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
   9. NFPA 70 – National Electrical Code (NEC).
   10. UL 1004, Electric Motors.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have not less than five years experience producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
   2. Motor manufacturer shall be one of the following:
      a. TECO – Westinghouse.
      b. US Motors.
      c. General Electric.
      d. Approved equal.
   3. Manufacturers listed are not guaranteed acceptance of a product that is proposed for this project. The motor supplied under this Section is required to meet all requirements stated in the Specifications.
   4. Motor Compatibility: Manufacturer shall provide confirmation that motor provided is compatible with driven equipment and complies with this Specification.

1.4 SUBMITTALS

A. The following information shall be provided for each motor in accordance with the requirements of this Section.
   1. Datasheets including motor outline, dimensions, and weight.
   2. Motor nameplate drawing.
   3. Manufacturer's general descriptive information relative to motor features.
   4. Details of motor heaters, winding thermal protection, and other accessories. Copies of motor characteristic curves and data inputs when required for programming motor protection and management relays.
   5. Motor test data:
      a. Submit testing data sheets for proposed motor(s). Values indicated on testing data sheets shall be from tests of a previously manufactured, electrically duplicate motor or calculated data. Mark each test data sheet to indicate the Project motor application location, manufacturer, type, frame size, horsepower, voltage, speed, bearing type, lubrication medium and enclosure type. Test data sheet shall also include:
         1) Winding resistances.
         2) Torque values.
         3) Efficiency at 100, 75, and 50 percent of full load.
         4) Power factor at 100, 75, and 50 percent of full load.
         5) Slip.
         6) Full load amperes.
         7) Locked rotor and no load amperes.
         8) Nameplate temperature and results of dielectric tests.
      b. Written reports presenting results of required shop testing. Shop test reports shall be dated and signed by motor manufacturer.
      c. Written reports presenting results of required field testing and inspections. Field testing reports shall be dated and signed by CONTRACTOR.
   6. Manufacturer's Instructions:
      a. Instructions and recommendations for handling, storing, protecting the motors.
      b. Installation data for motors, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
   7. Qualifications Statements:
      a. Submit manufacturer's qualifications data when requested by ENGINEER.
   8. Applicable operation and maintenance information specified in Section 01730, Operation and Maintenance Manuals. Provided overhaul instructions for the motor.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage, and handling shall comply with manufacturer's recommendations.

B. Ship motors with all enclosure openings sealed.

C. Protect materials and equipment from corrosion and deterioration. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

D. Provide and maintain temporary power for space heater operation during storage and prior to energization once installed in permanent location. Failure to energize space heaters during storage shall dictate that motors are subject to rejection as determined by the ENGINEER or OWNER pending any inspection or testing. All expenses for inspection, testing, returning motor to factory, and shipping replacement motor to the site shall be solely the responsibility of the CONTRACTOR.

E. Fill bearing oil reservoirs and bearing grease cavities to confirm bearings are properly lubricated and to prevent ingress of moisture during storage. Rotate motor shaft during storage in intervals recommended by the manufacturer.

1.6 WARRANTY

A. The manufacturer shall provide a single warranty against faults and defects in material and workmanship for a period of 24 months of operation from the date of successful commissioning. Warranty shall provide for free replacement or repair of parts during that time period including all necessary labor. Warranty shall be administered by the manufacturer or its authorized service representative.

PART 2 – PRODUCTS

2.1 AMBIENT CONDITIONS

A. Motors shall be suitable for the following service conditions:
   1. Outdoor installation exposed to weather.
   2. Continuous operation in a 50°C ambient temperature.
   3. Elevation of approximately 1000 feet above mean sea level.

2.2 POWER REQUIREMENTS

A. Motors shall operate from a power system supplying 480 volts, 3 phase, 60 hertz alternating current power.

B. Motors shall successfully operate under power supply variations in accordance with NEMA MG 1-14.30.

C. Motor current imbalance shall not exceed 10% when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system. Imbalance criteria shall be based upon the lowest current value measured.

2.3 CONSTRUCTION

A. Motors provided under this Section shall have the following features of construction and operation:
   1. Motor shall be three phase, full voltage start, squirrel cage induction motor that is suitable for operation on a solid-state reduced voltage motor controller. Motor shall have either a Design B or C torque-speed characteristic as required by the vertical turbine pump that it will power.
   2. Fabricated steel or cast-iron frames with integrally cast bases, cast-iron end bells, cast iron or steel conduit boxes and bases with precision machined bearing fits, ASTM A48/A48M, Class 25 minimum.
   3. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions. Motors shall operate within their full load rating without applying the service factor.
   4. Motor base speed RPM shall be as specified in the line shaft vertical turbine pump specification.
   5. Service Factor: Motors shall be rated for 1.15 Service Factor while operating on sine wave power in a 50°C ambient. Motors that can only operate at 1.15 Service Factor in a 40°C ambient will not be accepted. Motors that can only operate at 1.0 Service Factor at 50°C ambient will not be accepted.
   6. Efficiency: Motor minimum nameplate efficiency when operating on a sinusoidal power source shall comply with Table 12-12 of NEMA MG-1. Motor shall qualify for and be labeled as NEMA Premium Efficient.
   7. Stator Construction:
      a. Windings shall be copper.
      b. Stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.
      c. Insulation materials shall be non-hygroscopic and meet or exceed Class F definition, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests. Motor temperature rating shall not exceed Class B temperature limits as measured by resistance method when the motor is operated at full load at 1.0 service factor continuously in a maximum ambient temperature of 50°C.
   8. Rotor Construction:
      a. Rotor cages shall be die cast aluminum or fabricated copper. Shafts shall be made from carbon steel.
      b. Rotors on frames shall be keyed shrunk or welded to shaft and rotating assembly dynamically balanced to NEMA limits in accordance with MG 1-17.1. Balance weights, if required, shall be secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion resistant epoxy.
   9. Bolt and cap screws shall be high-strength, SAE Grade 5 zinc-plated chromatic steel. Screwdriver slot fasteners are unacceptable.
   10. Motors shall be shop-painted at the motor fabrication facility. Finish coat shall be the same color as the associated driven equipment. Final paint finish shall be corrosive resistant and capable of passing ASTM B117 250-hour salt spray test. Motors that will be located outdoors shall have coating resistant to degradation or chalking in sunlight.

11. Bearings:
    a. Motor bearings shall be adequately designed for the maximum load imposed by the driven equipment and motor and for all thrusts to which motor can be subjected. Rated minimum L10 life of the thrust bearings shall be at least 100,000 hours when operated at rated speed and full load thrust.
    b. Motors shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor.
    c. Maximum bearing temperature rise shall be 60°C under any conditions.
    d. Thrust bearings shall be oil-lubricated, anti-friction or sleeve type bearing with oil reservoir. Thrust bearing shall be of the air-cooled type or water-cooled type (if required).
    e. Lower radial guide bearings shall be grease lubricated, ball type. Bearings shall have inlet fittings and outlet plugs. Protect bearings and grease reservoirs from entry of contaminants. Provide suitable fittings to allow convenient positive purging of old grease during re-greasing.
    f. Oil lubricated bearings contained in oil reservoirs shall be provided with oil level sight gauges, oil fill and drain openings with plugs. Sight gauges shall be transparent vertical tube indicators with permanently-marked easily-discernible oil level. Sight gauges shall be mounted beside the bearing oil reservoir and shall be equal in height to the reservoir.
12. Insulation:
    a. Insulation systems shall be rated Class F, with a service factor of 1.15 times motor's nameplate horsepower rating when operated on a sine wave power supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with ambient temperature not exceeding 50 degrees C, unless specified otherwise in the Section for the associated driven equipment.
    b. Windings shall be epoxy-coated. Treat windings with insulating compound suitable for protecting against moisture, salt air, and slightly acidic and alkaline conditions. Insulation system for enclosed motors shall be upgraded to increase moisture resistance.
    c. Motors shall have vacuum/pressure-impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in temperature-controlled oven.
    d. Stator windings and end turn connections shall be fully brazed to withstand full voltage starting, regardless of the starting method indicated in the Section for the associated driven equipment. Bracing system shall essentially eliminate coil vibration under the high-current conditions of starting as well as during normal operation. When a tied system is used, system shall be such that no tie depends on the integrity of another tie within the system.
    e. Motors shall be form wound. Form wound coils with micaceous ground wall insulation shall have additional insulation and hot-pressed to provide sealed system. Complete stator shall be vacuum/ pressure-impregnated.
13. Enclosure:
    a. Totally enclosed fan cooled (TEFC): Cast-iron frame, cast-iron end brackets, cast iron fan covers, and cast-iron conduit box. Provide drain holes on each end of motor.

14. Motors shall have a Type P base specifically constructed for vertical installation. Universal position motors are unacceptable.
15. Motors shall be provided with solid shaft connections to the driven pump.
16. Motor conduit box shall be split from top to bottom, shall be capable of being rotated to four positions 90 degrees apart, and shall comply with the following:
    a. Box shall be gasketed with rubber-like gaskets between frame and conduit box and between conduit box and conduit box cover.
    b. Provide box or opening in motor housing with conduit hub type fitting to allow threaded conduit connections.
    c. Box sizes shall be in accordance with code requirements and shall accommodate medium-voltage terminations or stress cones, when required.
    d. Protective and auxiliary devices shall terminate in auxiliary conduit boxes.
    e. Terminal leads shall be flexible and of sufficient length to extend for distance of not less than ten inches beyond face of terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with non-wicking, non-hygroscopic insulating material, or insulating "wrap-cap" as manufactured by Ideal Industries, or equal.
    f. Provisions for terminal box size, length of leads, size of conduit openings, and type of terminal lugs shall be complied with irrespective of other standards or practice.
    g. Provide motor frame grounding stud inside conduit box. Stud shall include a drilled and tapped hole.
    h. Motor conduit box shall be fabricated from carbon steel and shall be painted to match the finish coat color of the motor enclosure.
14. Lifting Eyes:
    a. Provide two lifting eyes for the motor. Construct motor and lifting eyes to bear full weight of motor.
15. Non-Reverse Ratchet:
    a. Provide non-reverse ratchet (NRR) on motor to prevent spinning in opposite direction.

2.4 ACCESSORIES

A. Space Heater:
    1. Provide space heater within motor for condensation prevention. Space heater wattage shall maintain motor interior above dew point temperature at all times. Space heaters shall be low-density type for low surface temperature and long service life. Space heaters shall operate on 120 volts, single phase power.

B. Resistance Temperature Detectors (RTD's):
    1. Provide each motor with two 100 ohm platinum RTD's in each phase of the stator windings (total of six stator RTDs) and two 100 ohm platinum RTD's for each bearing (total of 4 bearing RTDs). The RTD's shall be three wire type.
    2. Leads from the RTD's shall be wired to a separate terminal box and installed through flexible sleeves from the stator windings. Sleeves shall be free of insulating varnish

or coating material applied to stator windings. Do not ground sensors or shields at motor.

C. Vibration Switch:
   1. Vibration switch unit shall measure vibration of the motor base and provide alarms when preset limits are exceeded. Unit shall consist of vibration sensor, transmitting cable, alarm output contacts and shall have the following characteristics:
      a. Adjustable warning and shutdown limits per the motor manufacturer's recommendation.
      b. Two sets of form C output contacts for indication of vibration warning and shutdown alarm at the motor protection relay.
      c. Supply voltage: 120VAC.
      d. Enclosure: NEMA 4X.
      e. Manufacturer: Metrix 440 Series, or Approved Equal.

2.5 NAMEPLATES

A. Nameplates shall be stainless steel with engraved or embossed lettering and shall be fastened to the motor frame with Type 316 stainless steel pins. Nameplates shall contain the following information:
   1. Motor manufacturer's name.
   2. Motor manufacturer type designation.
   3. Serial number.
   4. Frame designation.
   5. Enclosure.
   6. Weight.
   7. Balance.
   8. Shaft end bearing designation.
   9. Opposite shaft end bearing designation.
   10. Voltage.
   11. Phase.
   12 Hertz.
   13. RPM.
   14. Maximum Ambient Temperature.
   15. Duty.
   16. Insulation class.
   17. Horsepower.
   18. Full load (FL) amps.
   19. Service factor (SF) amps.
   20. NEMA nominal efficiency.
   21. Guaranteed efficiency.
   22. NEMA design letter.
   23. NEMA code letter.
   24. Nominal power factor.
   25. FL Kilowatt.
   26. Max Capacitor KVAR.
   27. FL torque.

B. Nameplates shall indicate that each motor is rated for the following:
   1. 50°C ambient.
   2. NEMA Premium Efficient.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Perform factory testing on the motors at the manufacturer's facility. Factory test shall be in accordance with NEMA MG 1, UL 674, and UL 1004 and shall demonstrate that the motors tested comply with the Contract Documents.
   2. Submit factory test reports identifying tests performed and results obtained.
   3. Motors shall be given a "Complete Test" in accordance with IEEE 112 consisting of a "Routine Test" and a full-load heat run. When "Complete Tests" are required for a group of the same type, rating and horsepower for the same application, each motor of the group shall be given a "Complete Test", unless specified otherwise in the Section for the associated driven equipment. Testing shall document the following:
      a. Percent **s**lip.
      b. No-**l**oad **s**peed, **v**oltage, **c**urrent, and losses at rated frequency.
      c. Full-**l**oad **c**urrent.
      d. Locked-rotor **t**orque.
      e. Locked-rotor **c**urrent.
      f. Breakdown **t**orque (**c**alculated).
      g. Starting **t**orque (squirrel-cage).
      h. Winding **r**esistance.
      i. Sound pressure level at no-load.
      j. Vibration levels.
      k. Efficiency current, and power factor at 100, 75, and 50 percent of full load and at service factor load.
      l. Stabilized full load temperature rise.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Install motors in accordance with the Contract Documents and manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of motors, unless approved in writing by ENGINEER.
   4. Carefully and properly align motors with the driven equipment.
   5. Secure motors to mounting surfaces with anchorage devices complying with manufacturer's recommendations that are of sufficient size and quantity to secure motor to equipment.

6. Until start-up and operation, tightly cover and protect motors from dirt, water, and chemical and mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Site Tests:
   1. Inspect motors prior to supplying electricity to (energizing) equipment. Do not energize equipment without ENGINEER's permission. Inspections shall include the following:
      a. Inspect motor and equipment for physical damage.
      b. Inspect motor for proper anchorage, mounting, grounding, connection, and lubrication.
      c. Check for unusual noise and indications of overheating during initial or test operation.
   2. Perform testing at the Site as follows:
      a. Testing shall be witnessed by OWNER.
      b. Initial inspections and testing shall include the following:
         1) Electrical and grounding connections.
         2) Shaft alignment, proper mounting and lubrication.
         3) Check ventilating air passageways for blockage.
         4) Excessive noise.
         5) Overheating.
         6) Correct rotation.
         7) Protective detectors operation.
         8) Excessive vibration.
         9) Space heater operation.
      c. Electrical testing shall include the following:
         1) Insulation resistance test.
         2) Surge comparison test.
         3) Vibration test.
         4) Bearing insulation resistance test on insulated bearings.
         5) Running current and voltage measurements and evaluations relative to load conditions over full range of operations and nameplate full-load amperes.
         6) High-potential test.
         7) Motor operation with the driven equipment for not less than 48 continuous hours per motor, with checks for overheating and vibration during operation.
      d. Tests and values shall be in accordance with motor manufacturer’s recommendations, NEMA MG 1 and ANSI/NETA ATS.
      e. Prepare and submit field testing report for all recorded data.

B. Manufacturer's Services:
   1. Furnish services of motor manufacturer's qualified service representative to assist with installing motors, checking installed motors before initial operation, assisting in performing field quality control tests and inspections, observing and assisting initial operations, and training operations and maintenance personnel in caring for, operating, and maintaining motors.

2. Preparing and submitting manufacturer's field report for each visit to the Site.

+ + END OF SECTION + +

40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Contractor, through the services of a single Process Control System Integrator (PCSI), shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete Process Control System (PCS).

B. The instrumentation and control (I&C) Work includes, but is not limited to, the following:
   1. Furnish and install primary sensors and field instruments as shown in Piping and Instrumentation Drawings (P&ID) and as specified in Section 40 70 05.
   2. Terminate I/O points as indicated on the P&IDs at the existing High Service Pump Station Control Panel JK-HS-PLC-01 located in the Main Electrical Building using new I/O modules as indicated on shown on the contract drawings.
   3. Furnish and install new Programmable Logic Controller (PLC) parts and relays in existing Control Panel JK-HS-PLC-01. Wire PLC modules to relays in the same fashion as the existing, label PLC parts and relays following the existing tagging and numbering.
   4. PLC programming for the existing PLC in the locations listed above shall be performed by the Application Service Provides (ASP) that shall be assigned by the Owner. This work is excluded from the Contractor Scope of Work.
   5. New Human Machine Interface (HMI) graphic screens to be developed and configured for supervisory control and monitoring of the equipment as shown and specified. HMI configuration shall be performed by the ASP that will be assigned by the Owner. This work is excluded from the Contractor Scope of Work.
   6. Provide start-up and field testing in accordance with Section 40 61 23.

C. P&ID's and Specifications of this Section and the other applicable instrumentation and control Sections illustrate and describe the required PCS and PCS functions and operational requirements.

D. Coordination:
   1. All equipment, components and materials required shall be furnished by the single PCSI who shall assume the responsibility for adequacy and performance of all items.
   2. PCS equipment shall be provided by a single PCSI who shall assume responsibility for providing a complete and integrated system.
   3. To the greatest extent possible, PCSI shall provide I&C materials and equipment from a single manufacturer.
   4. PCSI’s Responsibilities: CONTRACTOR shall retain the PCSI to undertake the responsibilities specified below. However, execution of these specified duties by the PCSI shall not relieve CONTRACTOR of the ultimate responsibility for the PCS.
      a. Preparing all process control equipment submittals in accordance with the Contract Documents.

b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with the Site's motor control center and other electrical systems.
c. Review and coordination with manufacturers, other suppliers, other contracts Shop Drawings and other CONTRACTOR submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
d. Direct, detailed oversight of installation of instruments, panels, wiring and other components, and related wiring and piping connections.
e. Some panels and equipment are furnished under other Specification Sections under this Contract. PCSI shall coordinate with suppliers of panels and equipment to provide fully functional system complying with the Contract Documents.
f. Update existing Control Panel JK-HS-PLC-01 wiring diagrams to add new signals and digital input modules wiring.
g. Use wiring diagrams in conjunction with the PLC input/output lists for coordinating signals between equipment provided under this contract. Include Work for CONTRACTOR-furnished control options not on the input/output list at no additional cost to the OWNER.
h. Coordinate with the ASP testing and startup activities.
i. Source quality control, field quality control, and start-up of the PCS.
j. Handling of all warranty obligations for the control system components.

E. Related Sections:
1. 40 61 23, Process Control System Start-up and Field Testing.
2. 40 61 93, Process Control System Input-Output List.
3. 40 61 96, Process Control Descriptions.
4. 40 70 05, Primary Sensors and Field Instruments.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. ANSI/ASQ Z1.4, Sampling Procedures and Tables for Inspection by Attributes.
2. ISA 5.1, Instrumentation Symbols and Identification.
3. ISA 5.4, Instrument Loop Diagrams.
4. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
5. IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
6. NFPA 79, Electrical Standard for Industrial Machinery.
7. UL 508A, Standard for Safety, Industrial Control Panels.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturers: Manufacturers of instrumentation and control equipment furnished for the PCS shall be experienced producing similar equipment and shall have the following qualifications:

a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
Shall have documented product safety policy relevant to materials and equipment proposed for the Work.

B. Process Control System Integrator (PCSI):
1. The Contractor shall provide the services of a pre-approved Process Control System Integrator (PCSI) for work under this Division and other Divisions, as described in this Division and other Divisions.
2. The PCSI shall be responsible for software programming and configuration of the existing PLC and HMI. The PCSI shall perform all work necessary to configure, customize, debug, and place into operation the new HMI screens in accordance with the requirement specified within this Division and other related divisions.
3. Where shown on the Bid Documents, the Contractor shall name the proposed PCSI.
4. The PCSI shall be one of the following:
a. Prime Controls
b. RLC Controls Inc.

C. Pre-submittal Conference
1. Schedule and conduct a pre-submittal conference for the PCS within 30 days after acceptance of PCSI by OWNER.
2. Required Attendance for Pre-submittal Conference: CONTRACTOR, PCSI, ENGINEER, and OWNER. Conference date and location shall be coordinated with OWNER and ENGINEER.
3. Purpose of pre-submittal conference is to review manner in which PCSI intend to comply with requirements of the Contract Documents relative to PCS submittals before submittals are prepared.
4. Bring to pre-submittal conference list of proposed personnel committed to assignment to the Project. List shall include PCSI project manager and field engineer.
5. Prepare items listed below for presentation at pre-submittal conference. Submit information to ENGINEER two weeks prior to pre-submittal conference.
a. List of materials and equipment required for PCS, and manufacturer and model proposed for each item.
b. List of currently known requests for interpretations of which CONTRACTOR and PCSI are currently aware.
c. List of proposed exceptions to the Contract Documents along with brief explanation of each.
d. Sample of each type of process control submittal required by the Contract Documents. These may be submittals prepared for other projects.
e. Schedule for project including, but not limited anticipated submittal delivery dates, and all other meetings anticipated for this Contract.
f. General outline of types of tests to be performed to verify that all field instruments, and digital processing equipment are functioning properly.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. PCS System:
         1) System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
            a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
            b) Wiring types, wire numbers, and color coding.
            c) Designation of conduits in which field I/O wiring will be installed.
            d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
   2. Product Data:
      a. Field Instruments:
         1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
         2) Instrument tag number in accordance with the Contract Documents.
         3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use.
         4) Description of construction features.
         5) Performance and operation data.
         6) Installation, mounting, and calibration details; instructions and recommendations.
         7) Service requirements.
         8) Range of each device and calibration information.
         9) Descriptions of materials of construction and listing of NEMA ratings for equipment.
      b. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.
      c. Product data for PCS, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.

B. Informational Submittals: Submit the following:
   1. Documents to be submitted prior to pre-submittal conference, in accordance with Article 1.3 of this specification.
   2. System Software Documentation: Software documentation shall include the following:
      a. Complete printed copies of all programming.
      b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
      c. Color copies of all configured HMI screens.
   3. Manufacturer's Instructions:

a. Shipping, handling, storage, installation, and start-up instructions.
b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.

4. Special Procedure Submittals:
   a. Notification to OWNER and ENGINEER at least 14 days before readiness to begin system checkout at the Site. Schedule system checkout on dates acceptable to OWNER and ENGINEER.
   b. Written procedure for system checkout. Submit not less than 90 days prior to starting system checkout.
   c. Ninety days prior to starting system checkout submit written procedure for start-up.
5. Field Quality Control Submittals:
   a. Submit the following prior to commencing system checkout and start-up.
      1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
   b. Field calibration reports
   c. Field testing reports.
6. Supplier's Reports:
   a. Installation inspection and check-out report.
   b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
7. Qualifications Statements:
   a. Manufacturers, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
      b. Software documentation: Include complete up-to-date system software documentation. Provide electronic copies in native formats.
      c. Provide for the PLC:
         1) Memory Map: Listing of all addresses in use in the PLC and associated address comment.
         2) Program Listing: Printout of entire PLC program, including address comments, rung comments, and address cross-references. Each address and rung shall have a comment descriptive of its function.
         3) PLC Configuration: Printout of all configuration information required by the PLC for operation, such as communication port configuration, I/O module configuration, and PLC settings.
         4) Include operator instructions for the operation and troubleshooting of each process control loop.
      d. Provide (2) flash drives containing all PLC and HMI native programming files and external application files. The flash drive contents shall allow OWNER to restore the system to the original state at which it was accepted.
   2. Record Documentation:
      a. Prepare and submit record documents in accordance with Section 01 78 39, Project Record Documents.

b. Revise all PCS Shop Drawings to reflect as-built conditions in accordance with the following.
   1) Use "as-built" updates of approved Shop Drawings and submittals in operation and maintenance manuals.
   2) Submit drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:
   1. Software:
      a. Submit native electronic copies of programming and configuration files developed specifically for the Project in accordance with Section 01 78 23, Operations and Maintenance Data. Complete all software service agreements and warranties in OWNER's name.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

PART 2 - PRODUCTS

2.1 PCS – GENERAL PROVISIONS FOR PRODUCTS

A. General:
   1. All electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, 60 Hertz plus-or-minus two Hertz power. If different voltage or closer regulation is required, provide suitable regulator or transformer.
   2. Unless otherwise shown or indicated in the Contract Documents, control system shall be furnished to use 4 to 20 mADC analog signals.
   3. Provide signal converters and repeaters where required. Analog inputs to the control system shall be through appropriate repeaters to provide signal isolation where series-looped with other devices and to allow loop to maintain integrity even when the control system is out of service. Power supplies shall adequate for signal converter and repeater loads.
   4. Signals shall be isolated from ground.
   5. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.
   6. PCS and associated input/output wiring will be used in a facility environment where there can be high-energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers or input contact locations and PCS components. PCS shall be adequate to provide proper protection against interferences from all such possible situations.
   7. Instrumentation and PCS components shall be heavy-duty types, suitable for continuous service in a municipal water treatment plant environment. Furnish products that are currently in production at the time products are shipped from the factory. All equipment furnished shall be of modular construction and be capable of

field expansion through installation of plug-in circuit cards and additional cabinets as necessary. Logic and control loops shall be fail-safe.

8. Instrumentation and other PCS components shall return automatically to accurate measurement within 15 seconds upon restoration of power after a power failure, and when transferred to standby power supply.
9. Provide surge protection for instruments and all other PCS components.
10. Field-mounted instruments and PCS components shall be suitable for installation in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes, and appurtenances shall comply with NEMA 4X requirements, unless otherwise shown or specified.
11. Provide interpose relays on PLC discrete inputs and outputs.
12. Relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are unacceptable.
13. Panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. Front-of-panel-mounted devices shall be of the same manufacturer and model line.
14. All components furnished, including field-mounted and rear-of-panel instruments, shall be tagged with the item number and nomenclature as shown and the instrument index in the Contract Documents or, as applicable, the "data sheets" that are part of the Contract Documents.
15. Ranges and scales specified in the Contract Documents shall be coordinated to suit equipment actually furnished. Range, scale, and set point values specified in other Sections of Division 40 are for initial setting and configuration. Coordinate specified values with actual equipment furnished to implement proper and stable process action as systems are placed in operation.
16. Field-mounted devices shall be treated with an anti-fungus spray.
17. Field-mounted devices shall be protected from exposure to freezing temperatures.

B. Environmental Conditions:
   1. PCS and its components shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
      a. Equipment and Devices Installed in Control Rooms or Electrical Rooms equipped with air conditioning units:
         1) Ambient Temperature: 60 degrees F to 80 degrees F normal range; and 40 degrees F to 105 degrees F occasional maximum extremes.
         2) Relative Humidity: 80 percent, normal; 95 percent maximum.
      b. Equipment and devices installed at indoor locations (other than control rooms) for digital processing equipment hardware, control panels, and instruments:
         1) Ambient Temperature: 40 degrees F to 120 degrees F.
         2) Relative Humidity: 98 percent maximum.
      c. Equipment and Devices Installed Outdoors:
         1) Ambient Temperature: -10 degrees F to 120 degrees F.
         2) Relative Humidity: 100 percent maximum.

2.2 PROGRAMMABLE LOGIC CONTROLLER

A. Existing PLC is a M340 as manufactured by Schneider Electric. Parts provided shall match existing:
   1. Digital Input Module: BMXDDI1602

2. 20-way removable terminal block: BMXFTB2000

2.3 RELAY

A. Existing relays are manufactured by Phoenix Contact. Parts provided shall match existing:
   1. Relay Power Terminal Block, PLC-ESK GY: 2966508
   2. Relay, 1 NO, 24VDC coil, 6A contact PLC-RSC-24DC/1AU/SEN: 2966317
   3. Terminal Block End Clamp: 0800886
   4. Terminal Block, Group Marker, KLM-A: 1004348

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

40 61 23 PROCESS CONTROL SYSTEM START-UP AND FIELD TESTING

PART 1 - GENERAL

1.1 SYSTEM CHECK-OUT AND START-UP RESPONSIBILITIES

A. CONTRACTOR shall be responsible for providing all labor, materials, equipment, and incidentals necessary to perform and coordinate the check-out, start-up, and field-testing of the instrumentation and control system. CONTRACTOR to coordinate the start-up and field-testing with the Application Service Provider (ASP) as required and applicable.

1.2 OPERATIONAL READINESS TEST (ORT)

A. Following installation of the process control system components and prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, wired, calibrated, tested, etc., and documented) that it is installed and ready for the ORT as defined below.

B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.

C. CONTRACTOR shall coordinate with the ASP and provide loop checks for all new I/O points including hardwired input/outputs from field instruments, RVSS panel and the PLC panel.

D. System checkout shall include, as a minimum, the following checks:
   1. All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.
   2. All instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings.

E. The Loop/Component Inspections and Tests shall be implemented using Engineer-approved forms and checklists. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check-off items with spaces for sign-off by the system supplier:
   1. Project Name, Test Date, and Lead Technician Names from CONTRACTOR and the ASP.
   2. Loop Number.
   3. Tag Number for each component.
   4. Check-offs/sign-offs for each component: Tag/identification; installation; termination (wiring and tubing); scale, range, and setpoint as applicable; and calibration/adjustment (four-point for analog, set point for switches) rising and falling.

5. Check-offs/sign-offs for the loop: Panel interface terminations; I/O interface terminations; I/O signal operation; inputs/outputs operational (received/sent, processed, adjusted); total loop operation; process controller scaling and adjustment; and space for comments.

F. The CONTRACTOR shall maintain the Loop Status Reports sheets at the job site and make them available to the Engineer/Owner at any time.

G. These inspections, calibrations, and tests do not require witnessing. However, the Engineer will review Loop Status Sheets and spot-check the CONTRACTOR test process periodically. Any deficiencies found shall be corrected by the CONTRACTOR prior to commencement of the Functional Demonstration Test.

H. Prior to checkout of the I/O to the HMI, the CONTRACTOR and ASP shall thoroughly test all I/O from the field device to the PLC terminals, and verify the PLC is powered up and the PLC is communicating to the HMI servers. After the CONTRACTOR has successfully tested all I/O from the field devices to the PLC terminals, the ASP shall test all I/O from the HMI to the field device. Should this test prove to be unsuccessful, the CONTRACTOR shall test from the field device to the terminations located in the Owner's termination cabinet, and shall inform the Owner in writing of the discrepancy with the existing field wire.

I. Computer-Manual (i.e., Remote-Manual) start/stop, open/close commands of all devices controlled by the SCADA system shall be verified by the CONTRACTOR and ASP during the ORT.

J. Upon successful completion of the ORT, the CONTRACTOR shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the FDT as noted in the following section.

1.3 FUNCTIONAL DEMONSTRATION TEST (FDT)

A. Prior to startup and the 30-day Site Acceptance Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the ORT.

B. FDT can only begin when all instruments and control panels are installed and wired. Operation and Maintenance manuals and a schedule for training must be approved prior to Commissioning. All spare parts must be on site and accepted prior to the FDT. CONTRACTOR shall submit to the Engineer a schedule for the FDT, including a proposed start date, at least two weeks in advance.

C. Once a process area has been started up and is operating, a witnessed FDT shall be performed on that system to demonstrate that it is operating and is in compliance with these Specifications. A witnessed FDT shall be performed on each process area. Each specified function shall be demonstrated on a paragraph-by-paragraph and loop-by-loop basis.

D. One copy of all O&M Manuals shall be available for reference at the job site, both before and during testing. CONTRACTOR shall provide the following documentation, as detailed in Section 40 61 13, Process Control System General Provisions, for use during the FDT:
   1. Complete schematic / point-to-point wiring drawings.
   2. Complete electrical control schematics.
   3. Complete field wiring diagrams.
   4. CONTRACTOR shall provide one set of test documents for the OWNER's personnel and the required number of sets for the CONTRACTOR's use.
   5. The drawings corrected and modified during the test shall form the basis for the "As-Built" record drawing requirement.

E. All PLC functions shall be thoroughly tested by the ASP to verify proper operation as an integrated system. System testing shall include, as a minimum, the following:
   1. All digital inputs shall be activated at the field element to verify proper response to the status change on graphic displays, reports, and in automatic control algorithms.
   2. All digital outputs shall be forced to verify proper control operation.
   3. All new graphic screens on the existing Plant HMI workstations shall be tested and verified.
   4. Alarm displays and printing shall be tested for all alarm points.
   5. All historical data collection, trending, computation, totalization and reporting functions shall be checked and tested to confirm proper operation and accuracy of the data.

F. Any defects or problems found in process control system during the test shall be corrected by CONTRACTOR and ASP and then retested to demonstrate proper operation

G. Following initial startup, the entire process control system shall operate for a continuous 100 hours without failure before this test will be started.

H. Punchlist items and resolutions noted during the test shall be documented on the Punchlist/Resolution form. In the event of rejection of any part or function test procedure, the CONTRACTOR shall perform repairs, replacement, and/or retest within 10 days.

I. Upon successful completion of the FDT, the CONTRACTOR shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the SAT as noted in the following section.

1.4 30-DAY SITE ACCEPTANCE TEST (SAT)

A. After completion of the Operational Readiness and Functional Demonstration Tests, the system shall undergo a 30-day Site Acceptance Test (SAT), under conditions of full plant process operation, without a single non-field-repairable malfunction.

B. During this test, plant operations, CONTRACTOR and ASP personnel shall be present as required to address any potential issues that would impact the overall system operation. The CONTRACTOR and ASP are expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system. When CONTRACTOR /

ASP personnel are not on-site, the CONTRACTOR / ASP shall provide cell phone/pager numbers that Owner personnel can use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.

C. While this test is proceeding, the Engineer and Owner's Agent shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain the responsibility of Owner and the decision of plant operators regarding plant operations shall be final.

D. Any malfunction during the tests shall be analyzed and corrections made by the CONTRACTOR or ASP. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

E. Any process control system malfunction during this 30 consecutive day test period which cannot be corrected by CONTRACTOR within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction. Upon completion of repairs by the CONTRACTOR, the SAT will be re-started from the date which the CONTRACTOR successfully corrected the malfunction(s) and the District and Engineer have accepted and signed off on the repairs.

F. In the event of rejection of any part or function, the CONTRACTOR shall perform repairs or replacement within 10 days.

G. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as:

Availability in percent = 100 * (Total Testing Time – Down Time) / Total Testing Time

H. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided shall not contribute to the availability test times above.

I. Throughout the duration of the 30-day SAT, no software or hardware modifications shall be made to the system without prior approval from the Owner and Engineer.

J. Upon successful completion of the 30-day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

K. Certification of Installation: Following successful completion of the 30-day test, the CONTRACTOR shall issue a Certification of Installation. Certification shall be on CONTRACTOR corporate letterhead and signed by an officer of the firm. Certification shall state that the process control system has been completed in conformance with plans and specifications. Certification shall be submitted to the Engineer as specified herein.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

40 61 93 PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section describes the process control system input/output (I/O) list, which follows this Section and requirements for configuring the control system database.

B. Related Sections:
   1. 40 61 13, Process Control System General Provisions.
   2. Section 40 61 96, Process Control Descriptions.

C. The I/O list information is available from the ENGINEER in electronic format.

1.2 SUBMITTALS

A. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the ENGINEER.

1.3 I/O POINT LIST DESCRIPTION

A. The I/O point list contains the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.

B. “RACK/SLOT/POINT” indicates the PLC rack number, module slot number and I/O point/channel number for each input/output point.

C. “TAGNAME” is an alphanumeric character string. For example, the point JK-WHS-P04-PL, the following apply:
   1. The first 2 characters identify the John Kubala Water treatment plant.
   2. The next three or four characters identify the process area, in the example the “WHS” represents West High Service pump station.
   3. The next one or two characters are the equipment identifier. In the example, the “P” represents Pump.
   4. The next two digit number identifies the equipment number. In the example, the “04” represents pump number 4.
   5. The final characters identified the input/output signal. In the example, the “PL” represents Pressure Low.

D. “DESCRIPTION” is an alphanumeric character string.

E. “SIGNAL TYPE” is one of the following:
   1. DI designates a hardwired discrete input.
   2. DO designates a momentary, maintained or latched hardwired discrete output.

3. AI designates a hardwired analog input.
4. AO designates a hardwired analog output.

F. “FROM/TO DEVICE” is used to show the source and destination of the I/O point.

G. “P&ID NO.” shows Process and Instrumentation drawing (P&ID) that contain the I/O point.

H. “COMMENT” shows comment for the I/O point.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 I/O CONFIGURATION

A. Implement the control system database fields in a consistent manner by using the following procedures:
1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.
2. Use only abbreviation or acronym for a word or group of words, respectively.
3. Use the same subject and word order within data fields.
4. Use the same term (either phrase, word, or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.
5. Use the point names, descriptions, logic state descriptions, ranges, and units of measurement the same wherever the point is referenced.
6. Show point names and descriptions for all point references on documentation.
7. Spell correctly.
8. Maintain lists of acronyms and abbreviations used.

3.2 I/O HARDWARE CONFIGURATION

A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.
1. Put all inputs of the same I/O type associated with a device (e.g., pump, blower, clarifier, or other piece of equipment) on the same card.
2. Put all inputs of the same I/O type for devices arranged in process trains (e.g., a pump, its inlet valve, and its outlet valve) on the same card or cards if more than one card is required to accommodate the points.
3. Put all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or cards if more than one card is required to accommodate the points.
4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.
5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling and termination internal to the PLC or RIO panels as done for other I/O points.

3.3 POINT DATA FIELDS

A. I/O point data fields may be subject to review and modification by the ENGINEER during the Shop Drawing review phase. Incorporate changes directed by the ENGINEER completely into the entire system, at no additional cost to OWNER, subject to the following limitations:
   1. Limit the total number of modifications to 20 percent of the total number of I/O points.
   2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input count as three modifications.
   3. Analog input alarm limit definition will not be counted as a modification.

+ + END OF SECTION + +

INPUT OUTPUT LIST

RACK_SLOT_CH	TAGNAME	MODULE/POINT DESCRIPTION	POINT TYP	P&ID	Comments
R1_S10_00	JK_WHS_P04_RM	West High Service Pump No WP-4 Control Mode Status	DI	I-03	New Module
R1_S10_01	JK_WHS_P04_RN	West High Service Pump No WP-4 Run Status	DI	I-03	New Module
R1_S10_02	JK_WHS_P04_FA	West High Service Pump No WP-4 Fail Alarm	DI	I-03	New Module
R1_S10_03	JK_WHS_P04_PAH	West High Service Pump No WP-4 High Disch Press Alarm	DI	I-03	New Module
R1_S10_04	JK_WHS_P04_TAH	West High Service Pump No WP-4 High Motor Wind Temp Alarm	DI	I-03	New Module
R1_S10_05	JK_WHS_P04_PAL	West High Service Pump No WP-4 Low Disch Press Alarm	DI	I-03	New Module
R1_S10_06	JK_WHS_P04_VAH	West High Service Pump No WP-4 High Vibration Alarm	DI	I-03	New Module
R1_S10_07	JK_WHS_P04_VAHH	West High Service Pump No WP-4 High High Vibration Alarm	DI	I-03	New Module
R1_S10_08	JK_WHS_VL20_RM	West High Service Pump No WP-4 Disch Valve Control Mode Status	DI	I-03	New Module
R1_S10_09	JK_WHS_VL20_RD	West High Service Pump No WP-4 Disch Valve Ready (5% Open) Status	DI	I-03	New Module
R1_S10_10	JK_WHS_VL20_CL	West High Service Pump No WP-4 Disch Valve Closed Status	DI	I-03	New Module
R1_S10_11	JK_WHS_VL20_OP	West High Service Pump No WP-4 Disch Valve Open Status	DI	I-03	New Module
R1_S10_12	JK_WHS_VL20_AL1	West High Service Pump No WP-4 Disch Valve Fail to 5% Open Alarm	DI	I-03	New Module
R1_S10_13	JK_WHS_VL20_AL2	West High Service Pump No WP-4 Disch Valve Fail to 100% Open Alarm	DI	I-03	New Module
R1_S10_14	JK_WHS_VL20_AL3	West High Service Pump No WP-4 Disch Valve Actuator Fail Alarm	DI	I-03	New Module
R1_S11_00	JK_WHS_P05_RM	West High Service Pump No WP-5 Control Mode Status	DI	I-03	New Module
R1_S11_01	JK_WHS_P05_RN	West High Service Pump No WP-5 Run Status	DI	I-03	New Module
R1_S11_02	JK_WHS_P05_FA	West High Service Pump No WP-5 Fail Alarm	DI	I-03	New Module
R1_S11_03	JK_WHS_P05_PAH	West High Service Pump No WP-5 High Disch Press Alarm	DI	I-03	New Module
R1_S11_04	JK_WHS_P05_TAH	West High Service Pump No WP-5 High Motor Wind Temp Alarm	DI	I-03	New Module
R1_S11_05	JK_WHS_P05_PAL	West High Service Pump No WP-5 Low Disch Press Alarm	DI	I-03	New Module
R1_S11_06	JK_WHS_P05_VAH	West High Service Pump No WP-5 High Vibration Alarm	DI	I-03	New Module
R1_S11_07	JK_WHS_P05_VAHH	West High Service Pump No WP-5 High High Vibration Alarm	DI	I-03	New Module
R1_S11_08	JK_WHS_VL24_RM	West High Service Pump No WP-5 Disch Valve Control Mode Status	DI	I-03	New Module
R1_S11_09	JK_WHS_VL24_RD	West High Service Pump No WP-5 Disch Valve Ready (5% Open) Status	DI	I-03	New Module
R1_S11_10	JK_WHS_VL24_CL	West High Service Pump No WP-5 Disch Valve Closed Status	DI	I-03	New Module
R1_S11_11	JK_WHS_VL24_OP	West High Service Pump No WP-5 Disch Valve Open Status	DI	I-03	New Module
R1_S11_12	JK_WHS_VL24_AL1	West High Service Pump No WP-5 Disch Valve Fail to 5% Open Alarm	DI	I-03	New Module
R1_S11_13	JK_WHS_VL24_AL2	West High Service Pump No WP-5 Disch Valve Fail to 100% Open Alarm	DI	I-03	New Module
R1_S11_14	JK_WHS_VL24_AL3	West High Service Pump No WP-5 Disch Valve Actuator Fail Alarm	DI	I-03	New Module
R0_S03_14	JK_WHS_P04_SC	West High Service Pump No WP-4 Start Command	DO	I-03	Existing Module
R0_S03_15	JK_WHS_P05_SC	West High Service Pump No WP-5 Start Command	DO	I-03	Existing Module

40 61 96 PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Application Service Provider (ASP) is responsible for reprogramming and configuring the High Service Pump PLC Replacement Panel JK-HS-PLC-01.
   2. ASP is responsible for configuring graphic screens on existing JK-HS-PLC-01 graphic terminal HMI to include graphic screens for the new west high service pumps.

B. Related Sections:
   1. 40 61 13, Process Control System General Provisions.

C. Process Control Functions:
   1. Process control function shall be structured to permit the realization of all control strategy requirements. In addition, each control function shall be designed so that bumpless, balance free transfers are obtained during operating mode changeover and initialization. Where applicable, user-changeable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.
   2. The P&IDs represent the required process monitoring and control. The required control for the system is a combination of the representation on the P&IDs and the requirements specified herein. The P&IDs do not show all the required internal diagnostic indications. In addition, to the indications shown on the P&IDs the following, at a minimum shall be provided:
      a. Indication of bad quality on any hardwired input/output point (such as zero milliamps on a 4 to 20 mADC circuit).
      b. Individual PLC fault indications.
      c. Indication of a communications failure.
      d. For all motor start and stop commands check for run feedback after adjustable time delay (0 to 30 seconds). Provide a “FAIL TO START” and “FAIL TO STOP” alarm if unit fails to run or stop. Use the bad start or stop bit to remove the run command from the control logic. When equipment fails to start, run the next available parallel unit in the lead-lag or lead-standby sequence.
      e. For analog control loops, when control of field equipment is not in “REMOTE” or “COMPUTER,” the associated PID controller output shall track the position feedback.
      f. Runtimes shall be provided for all motorized equipment.
      g. Totalize all flows.
      h. Provide the following alarm indications for analog signals (as required):
         1) “High-high.”
         2) “High.”
         3) “Low.”
         4) “Low-low.”

5) “High and low rate of change.”

3. In addition to the indications shown on the P&IDs, the following shall be provided at a minimum:
   a. Analog Data Scaling: This control function shall scale all analog inputs to a common span and shall normalize the digital representation of each analog input to a percent of the operating span. The processed value shall be expressed as a binary number that specifies the analog input's position on a straight line lying between zero and full scale as defined for a given input by the zero span values in the data base.
   b. Amplitude Limit Check: This control function shall perform dual level, high/low amplitude limit checking and shall identify a limit violation every time a measured or virtual variable goes out-of-limits and returns back into limits. The control function shall determine the time at which each limit excursion occurred. A deadband shall be provided on each limit and shall be expressed as a percentage of span or in engineering units. Low and high limiting default values will be set-up for each measured or calculated variables used in the process control loops.
   c. Engineering Unit Conversion: This control function shall convert scaled analog data to engineering units by means of the following equation:

      $$Y = (H - L)(D/DH) + L$$

      where:

      Y = Value in engineering units.
      H = High value of span, expressed in engineering units.
      L = Low value of span, expressed in engineering units.
      D = Digitized scaled input value in counts.
      DH = Full scale digitized value in counts.
   d. Manual Control: It shall be possible for Operator or Plant Engineer to interrupt any sequence, loop or automatic operation and operate the same manually through the Operator Workstation.
   e. Verification of Digital Outputs: This control function shall verify that the equipment has responded to the digital commands before proceeding to next step during automatic operation. If any discrepancy is detected, an alarm will be annunciated.

D. Configuration: All set points, tuning parameters and engineering scales etc. shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during Factory Testing and finally during start-up.

E. Communications:
   1. Move all data to be read by the operator interface software into a contiguous block. Make data register block location and range consistent between each PLC.
   2. Move all data to be read or written to another PLC into a contiguous block. Make data register block location and range consistent between each PLC.
   3. Leave 50 percent spare unused register space at the end of each data register block for future expansion of data to be communicated.

F. All scales, configuration values, mathematical constants, equations and set points given in the control strategies are adjustable over a wide range. The values given are initial and may change during Shop Drawing review and may have to be readjusted during start-up.

1.2 SUBMITTALS

A. The control strategies are written descriptions of the basic configuration and/or programming required to implement regulatory and sequential control of the unit processes as shown on the P&IDs. They do not in all cases describe the process characteristics fully. Finalizing and tuning of strategies, as required, by process characteristics shall be accomplished during start-up. Control strategies shall fully reside in the memory of the designated PLC. The process inputs/outputs referred to in the Control Strategies are shown on the P&IDs and Process Control System Input / Output list. Any additional I/O (Maximum 20 percent) required shall be added during Shop Drawing review. It shall be provided at no additional cost to the OWNER.

1.3 TERMS AND DEFINITIONS

A. The following represents the requirements for all control loops. These process control descriptions shall be used in conjunction with all project drawings and specifications.

B. Local Operation – Describes the manual operation of a device or piece of equipment at the facility which includes MCC, Field Control Stations and local equipment panels.

C. Remote Operation – Describes the operation of a device or piece of equipment from the SCADA HMI Workstations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 JKWTP - HIGH SERVICE PUMP PLC REPLACEMENT PANEL

A. General:
   1. Associated P&ID: I-03
   2. Equipment:
      a. High Service Pump 4: JK-WHS-P04
      b. High Service Pump 5: JK-WHS-P05
   3. Primary Instruments:
      a. High Service Pump 4, discharge side low pressure switch JK-WHS-PL04
      b. High Service Pump 5, discharge side low pressure switch JK-WHS-PL05
      c. High Service Pump 4, discharge side high pressure switch JK-WHS-PH04
      d. High Service Pump 5, discharge side high pressure switch JK-WHS-PH05

B. Process Description:

1. Two new high service pumps will be constructed to operate in parallel with the existing High Service Pumps.
2. There will be two high service pumps, driven by 300 HP, electric motors that can pump filtered water from the clear wells into the West Plane. New pump no.4 and pump no.5 shall be equipped with RVSS only.
3. The operator can start or stop any pumps either in local mode at the RVSS panels, or in the remote mode at the SCADA HMI workstation. The local/remote mode can be selected at the RVSS panels. The pumps are primarily intended to be operated in Remote-Manual mode from the SCADA HMI workstation.

C. Local Display and Control at the RVSS panel JK-WHS-RVSS04 and JK-WHS-RVSS05; provided under the Electrical sections:
   1. Local-Off-Remote (LOR) selector switch
   2. Emergency Stop pushbutton
   3. Start and Stop pushbuttons
   4. Running status light
   5. Pump discharge valve 5% Open status light
   6. Pump discharge valve 100% Open status light
   7. Pump discharge valve Closed status light
   8. Motor Winding High Temperature alarm light
   9. Motor Vibration High alarm light
   10. Starter Fault alarm light
   11. Overload alarm light
   12. High Discharge Pressure alarm light
   13. Low Discharge Pressure alarm light
   14. Reset pushbutton

D. Local Control at the valve actuator JK-WHS-VL11:
   1. Local-Off-Remote (LOR) selector switch
   2. Open, Stop and Close pushbuttons
   3. Open and Close status light
   4. Actuator Fault alarm light

E. Hardwired interlock at RVSS panel: Following steps must be hardwired at the high service pumps RVSS panel for a pump startup or shutdown:
   1. Pump Startup:
      a. Following permissive must be met:
         1) Pump LOR switch should be either in Local or Remote.
         2) Pump discharge valve LOR switch must be in Remote.
         3) E-stop is not pressed.
         4) No protective interlocks are active (see protective interlock list in below)
      b. If all above permissive are met, then following steps should take place in order:
         1) Send Open command to the pump discharge.
         2) When discharge valve is 5% open (determined using a limit switch) turn on the pump.
   2. Following protective interlocks shall not allow the pump to start and should initiate Pump Shutdown sequence (see below) if the pump is running:

a. High discharge pressure (JK-WHS-PH04 and JK-WHS-PH05)
b. Low discharge pressure (JK-WHS-PL04 and JK-WHS-PL05)
c. High motor winding temperature (trip contact from Motor Protection Relay installed at the RVSS)
d. High motor vibration (trip contact from Motor Protection Relay installed at the RVSS)
e. Discharge valve could not reach 100% open (after an adjustable time) after starting the pump.

F. Pump Shutdown: When a pump stop command is given or any protective interlocks occur, the following should take place (in this order):
1. Send close command to the discharge valve.
2. When discharge valve reached to 5% open, turn off the pump.
3. Discharge valve continues to close completely.

G. Remote Control and HMI Monitoring for high service pumps:
1. When the LOR switch at the RVSS panel is placed in Remote position, control will be through the PLC in JK-WHS-LCP01.
2. There is no remote automatic mode for the high service pumps.
3. When the pump LOR selector switch at the RVSS panel is in Remote position the operator shall be able to start/stop the pump remotely.
4. Remote Pump Start: following permissive must be met:
    1) Pump LOR switch should be in Remote.
    2) Pump discharge valve LOR switch must be in Remote.
    3) E-stop is not pressed.
    4) Number of motor starts per hour has not been violated.
    5) No protective interlocks are active (see protective interlock list in clause 3.1.E.2 above)
    b. If all above permissive are met then the operator will be able to start the pump, the PLC will send the start command to the RVSS and the hardwired startup sequence will be executed.
5. Remote Pump Stop: the stop command issued by the operator will be send to the RVSS panel by the PLC and the hardwire shutdown sequence will be executed.

H. Minimum HMI Screen Requirements:
1. West high service pump WP-4 and WP-5 graphic screen:
    a. Pump Running status
    b. Pump In Remote status
    c. Discharge Valve In Remote status
    d. Popup screen for the pump should include start/stop, running feedback, and common fault display.
    e. Pump Common Fault alarm: combining alarms for high discharge pressure, low discharge pressure, high vibration, motor winding high temperature, RVSS fault, fail to run, and fail to stop. Individual alarms shall be shown on Alarm Summary page.

f. Valve Common Fault alarm: combining alarms for actuator fault, fail to reach 5%, and fail reach 100% open. Individual alarms shall be shown on Alarm Summary page.

40 70 05 PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR, through the services of a single Process Control System Integrator (PCSI) shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all primary sensors and field instruments shown and specified herein.
   2. Specifications and drawings illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. PCSI shall provide all components, piping, wiring, accessories required for a complete, workable, and integrated system.
   3. CONTRACTOR shall be responsible for providing taps in the process piping systems for installation of field instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

C. Related Sections:
   1. 40 05 05, Exposed Piping Installation.
   2. 40 05 23.23, Stainless Steel Process Pipe for Liquid Service.
   3. 40 61 13, Process Control System General Provisions.
   4. 40 61 23, Process Control System Startup and Field Testing.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

B. Acceptable Manufacturers:
   1. Furnish primary process measurement devices by the named manufacturers or equal equipment by other manufacturers.
   2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
   3. Obtain all sensors and field instruments of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
   1. Design and manufacture the primary process measurement devices in accordance with the applicable general design requirements specified in Section 40 61 13, Process Control System General Provisions, and the detailed Specifications herein.
   2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 40 61 13, Process Control System General Provisions.

B. Primary process measurement devices shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the ENGINEER.

1.4 SUBMITTALS

A. Comply with the requirements specified in Section 40 61 13, Process Control System General Provisions.

1.5 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

A. Provide compatible materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the process fluids listed in the Instrument Index.

1.6 IDENTIFICATION TAGS

A. Performance Requirements:
   1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier. All instruments, whether field or panel mounted, shall have an identification tag.
   2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
   3. The tags shall be fastened to the device with self-tapping stainless-steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circlet of stranded stainless-steel wire rope and clamp.
   4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

B. Construction Features:
   1. Tags shall be engraved with 3/16-inch letters and constructed as follows.
      a. 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
      b. Core to be black; cover sheet to be white.
      c. Mounting holes to be centered on width and 1/4-inch from each end.

1.7 FILLING LIQUID

A. Use glycerin except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.

PART 2 - PRODUCTS

2.1 PROCESS TAPS, SENSING LINES AND ACCESSORIES

Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:

1. Material: Type 316 stainless steel; .035 wall thickness.
2. Pressure Rating: 150 psi.
3. Size: 1/2-inch O.D. for water.
4. Connections: Type 316 stainless steel compression type, "Swagelok", as manufactured by Crawford or equal.
5. Shut-off Valves:
   a. Type: Swaged end Ball.
   b. Type of Service: Ozone Residual sample, air, oxygen gas, ozone
   c. Type of end connection: 316L stainless steel compression type - swaged end connections
   d. Size: 1/2-inch
   e. Pressure Rating: 2500 psig.
   f. Description:
      1) Body and wetted parts: 316 stainless steel.
      2) Ball stem: 316 stainless steel.
      3) Packing bolt: 316 stainless steel.
      4) Bushing: PTFE.
      5) Packing: PTFE.
      6) Factory cleaned, packed and labeled for oxygen service
   g. Manufacturer and Product:
      1) Swagelok, 40 Series, Instrument Ball Valve.
      2) Or equal.
6. Manifolds:
   a. Type: 3-valve meter manifolds.
   b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; teflon packing.
   c. Products and Manufacturers: Provide one of the following:
      1) Anderson-Greenwood.
      2) Whitey.
      3) Or equal.

B. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches:

1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
   a. Material and Fittings: Type 316 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403).
   b. Sizes: 1/2-inch minimum for main sensing piping and 1/4-inch gauge and switch connections.
   c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Exposed Piping Schedule in Section 40 05 05, Exposed Piping Installation.
   d. Accessories:
      1) For applications not requiring diaphragm seals, provide separate 1/2-inch Type 316 stainless steel threaded ball valve for each gauge and switch.
      2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff.

2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
    a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. PVC pipe and fittings shall be provided in accordance with the requirements of Section 40 05 31, Thermoplastic Process Pipe.
    b. Sizes: 1/2-inch minimum for main process sensing piping and 1/4-inch for gauge and switch connections.
    c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 40 05 05, Exposed Piping Installation.
    d. Accessories:
        1) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.
        2) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff.

2.2 PRESSURE GAUGE – BOURDON TUBE

A. Type: Bourdon Tube Pressure Element Type, Liquid Filled Gauge (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):

B. Performance Requirements:
    1. Range: As specified in the Instrument Index.
    2. Accuracy: ±0.5 percent of span (ANSI B40.1 Grade 2A).

C. Construction Features:
    1. Case:
        a. Solid front design constructed of glass filled polyester.
        b. Color: Black.
    2. Dial size: 4-1/2-inch.
    3. Ring: Threaded, glass filled polyester.
    4. Window: Glass.
    5. Dial: White with black markings.
    6. Filling Liquid: See Article 1.7.
    7. Overpressure protection: Full blowout back.
    8. Bourdon Tube and Socket:
        a. Type 316 stainless steel.
        b. Heliarc welded, unless otherwise specified.
    9. Movement:
        a. Type 300 series stainless steel.
        b. Rotary geared with Teflon S coating, or cam and roller type.
        c. Built-in overload and underload movement stops.
    10. Connection: 1/4-inch male NPT, bottom.
    11. Mounting: Stem Mount.
    12. Calibration:
        a. Adjustable pointer.
        b. Externally accessible zero adjustment.

D. Accessories:
    1. Pressure Snubber: Sintered stainless steel snubber threaded into gauge socket or in external stainless steel housing with 1/4-inch NPT male and female connections.

2. Process Isolation: Provide ball valves for process isolation in accordance with the requirements of Article 2.1, above.

E. Products and Manufacturers: Provide one of the following:
   1. Ashcroft, Duragage 1279 Series.
   2. Wika.
   3. Or equal.

2.3 PRESSURE SWITCH

A. Type: Switch assembly with diaphragm/piston pressure sensor.

B. Function: Sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.

C. Performance Requirements:
   1. Operating Range: As specified in the Instrument Index.
   2. Setpoint: As specified in the Instrument Index.
   3. Setpoint Repeatability: ± One percent of range.
   4. Output: Snap action switch, SPDT rated not less than ten amps resistive at 120 Vac and 1/2 amp resistive at 125 VDC.
   5. Switch and Reset Action: Adjustable dead band.
   6. Adjustable Dead band Range and Setting: As specified in the Instrument Index.
   7. Ambient Temperature Limits: -4 degrees F to 140 degrees F.

D. Construction Features:
   1. Pressure Transducer Housing and Diaphragm Materials: Coordinate with the process piping materials.
      a. Water Service with Copper Pipe: Brass housing with Buna-N diaphragm.
      b. Other Services: Housing and diaphragm to be compatible with the process fluid as indicated in the Instrument Index.
   2. Set and Reset Point Adjustments: Adjustable external adjusting nuts and pressure setting scales in psi.
   3. Process Connection: 1/4-inch NPT.
   4. Housing: Copper-free die cast aluminum, NEMA 4. NEMA 7 construction required for hazardous locations.
   5. External Mounting Lugs.
   6. Adjusting Nuts Metal Cover with Gasket.
   7. Electrical Connection: 3/4-inch NPT.

E. Products and Manufacturers: Provide one of the following:
   1. Ashcroft.
   2. United Electric.
   3. Or equal.

2.4 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, identical to and interchangeable with similar parts furnished under this Section.

B. 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. The following shall constitute the minimum spare parts:
   1. A one-year supply of all expendable materials.
   2. One set of gauge and switches, ready for use.
   3. One dozen of each type and size of fuse used in the instruments.

D. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONTRACTOR shall require the PCSI to furnish the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Instruments, which require access for periodic calibration or maintenance, shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.

C. All items shall be mounted and anchored using stainless steel hardware, unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands or brackets as required by the manufacturer and as shown.

E. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions, Section 40 61 23, and Process Control System Startup and Field Testing.

+ + END OF SECTION + +

INSTRUMENT INDEX

INSTRUMENT TAG	DESCRIPTION	SPEC. SEC	SERVICE	RANGE / SETPOINT	P&ID	NOTES
JK-WHS-PG04	West High Service Pump No WP-4 Pressure Gauge	40 70 05 - 2.2	FW	0 - 160 psi	I-03	
JK-WHS-PH04	West High Service Pump No WP-4 High Pressure Switch	40 70 05 - 2.3	FW	0 - 160 psi/ 135psi	I-03	
JK-WHS-PL04	West High Service Pump No WP-4 Low Pressure Switch	40 70 05 - 2.3	FW	0 - 15 psi/ 1psi	I-03	
JK-WHS-PG05	West High Service Pump No WP-5 Pressure Gauge	41 70 05 - 2.2	FW	1 - 160 psi	I-03	
JK-WHS-PH05	West High Service Pump No WP-5 High Pressure Switch	40 70 05 - 2.3	FW	0 - 160 psi/ 135psi	I-03	
JK-WHS-PL05	West High Service Pump No WP-5 Low Pressure Switch	40 70 05 - 2.3	FW	0 - 15 psi/ 1psi	I-03	

43 21 13.33 VERTICAL LINESHAFT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Included are vertical lineshaft pumps, motors, couplings, bases, drives, anchorage systems and all appurtenances.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before centrifugal vertical lineshaft pump Work.

C. Related Sections:
   1. Section 01 65 00, Product Delivery Requirements
   2. Section 01 66 00, Product Storage and Handling Requirements
   3. Section 03 60 00, Grouting
   4. Section 05 05 33, Anchor Systems
   5. Section 09 91 00, Painting
   6. Section 40 05 93, Common Motor Requirements for Process Equipment
   7. Section 40 70 05, Primary Sensors and Field Instruments

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. American Bearing Manufacturers Association (ABMA).
   2. American National Standards Institute (ANSI).
   3. ASTM A48/A48M, Specification for Grey Iron Castings.
   4. American Water Works Association (AWWA).
   5. ANSI/HI 2.3, Vertical Pumps for Design and Application.
   6. ANSI/HI 2.4, Vertical Pumps for Installation, Operation, and Maintenance
   7. ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
   8. ANSI/HI 9.1-9.5, Pumps – General Guidelines.
   9. ANSI/HI 9.6.2, Centrifugal and Vertical Pumps for Allowable Nozzle Loads
   10. ANSI/HI 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Values.
   11. ANSI/HI 9.6.5, Centrifugal and Vertical Pumps for Condition Monitoring
   12. ANSI/HI 9.8, Pump Intake Design.
   13. ANSI/NSF 61 Drinking Water Components – Health Effects
   14. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   15. IEEE 85, Airborne Sound Measurements- Rotating Electrical Machinery.
   16. National Electrical Manufacturers' Association (NEMA).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years' experience producing substantially similar equipment to that specified in this Section and shall be able to document at least five installations in satisfactory operation for at least five years.

B. Welding Qualifications: Equipment manufacturer's shop welds and welding procedures and personnel shall be qualified and certified per AWS D1.1/D1.1M.

C. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of component manufacturer from a single centrifugal vertical lineshaft pump manufacturer.
   2. The equipment manufacturer shall prepare, or review and approve all Shop Drawings and other submittals for components furnished under this Section.
   3. Components shall be specifically constructed for specified service conditions and be integrated into overall assembly by centrifugal vertical lineshaft pump manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Manufacturer's literature, illustrations, specifications, paint certification and engineering data including; dimensions, materials, size, weight. and part lists for all components in sufficient detail to allow an item by item comparison with the Contract Documents.
      b. Performance data and curves showing overall pump efficiencies, required net positive suction head, allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Curves shall range from minimum flow to shut-off head at for full speed and all speed curves specified. For variable speed units, curves shall have at least five speeds plotted between maximum and minimum rpm. Provide data on pump head losses to include entrance, bowl, column, and discharge head losses.
      c. Minimum submergence required over suction bell at minimum head listed in service conditions in Part 2 of this Specification.
      d. Curve of down-thrust versus capacity for the entire range of operation from shutoff to minimum head conditions.
      e. Upthrust at starting.
      f. Wr^2 of pump.
      g. Impeller diameter.
      h. Motor test reports for furnished motors or for a previously manufactured electrically duplicate motor that was tested, including running light current, locked rotor current, winding resistance measurement, high potential test, bearing inspection, and efficiency at 1/2, 3/4, and full load.
   2. Shop Drawings:
      a. Drawings of the products, including fabrication methods, assembly, accessories, installation details, dimensions, and wiring diagrams.

3. Samples:
    a. Paint color samples for finish on pumps and motors. Color samples shall conform to Section 09 91 00, Painting.
4. Delegated Design Submittals:
    a. Analysis and calculations by a qualified specialist for critical speed of pump and motor shaft.
5. Testing Plans, Procedures and Testing Limitations:
    a. Proposed shop test procedures and field test procedures, and location of the shop tests.
    b. Location of nearest permanent service headquarters of pump manufacturer to the Site.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Provide welding certifications.
2. Source Quality Control Submittals:
    a. Shop tests. Provide prior to shipment from factory.
    b. For Project with required efficiency guarantees by pump manufacturer, provide a statement regarding compliance with the specified bowl efficiency and guaranteed wire-to-water efficiency for each pump/motor combination at design point listed in the service conditions in Part 2 of this Section.
3. Site Quality Control Submittals:
    a. Field operating tests.
4. Manufacturer's Instructions: Submit manufacturer's instructions and recommendations for:
    a. Storage.
    b. Handling.
    c. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
    d. Installation.
5. Manufacturer's Reports:
    a. Submit a written report of the results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.
6. Qualifications Statements:
    a. Submit qualifications data as specified in the Quality Assurance section.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
    a. Submit complete operation and maintenance manuals, including copies of test reports, maintenance data, and schedules, description of operation, and spare parts information.
    b. Furnish operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
2. Warranty Documentation:
    a. Provide a copy of the manufacturer's standard warranty for parts and labor.

D. Maintenance Materials Submittals: Furnish the following:

1. Spare Parts:
    a. Provide tools and spare parts as specified in the Maintenance article of this Specification.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
    1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment. Protect machined surfaces and matching connections to prevent damage.
    2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.
    3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
    4. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
    1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
    2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

1.6 MAINTENANCE

A. Special Tools: Furnish two sets of special tools required for normal operation and maintenance of products furnished.

B. Extra Materials:
    1. Furnish the following spare parts for each centrifugal vertical lineshaft pumps furnished under the Contract:
        a. Three (3) sets of bowl and impeller wear rings
        b. One year's supply of lubricants required for pump and bearings.
        c. Complete set of fasteners, bolts, nuts, pins, keys, and washers that are not of standard manufacture.
    2. Furnish and deliver spare parts carefully packed in sturdy containers with clear indelible identification markings. Store spare parts as recommended by manufacturer until transferred to OWNER.
    3. Product manufacturer shall provide a list of additional recommended spare parts for an operating period of one year. List shall describe each part, quantity recommended, and manufacturer's standard unit price for the part.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Description: Equipment provided shall be suitable for process and service conditions specified in the Contract Documents and shall conform to ANSI/HI 2.3. These pumps will be used to pump finished water from the clearwells into the distribution system. Pumps shall be designed, constructed, and installed for service intended and shall comply with the service conditions listed below.

B. Pump's characteristic curve shall rise continuously from minimum head condition to shutoff without dips. Complete pumping unit, consisting of suction/intake, bowl(s), column, pump head, motor, and appurtenances shall be suitable in all respects for continuous, stable performance when operating at each point on pump's characteristic curve between not greater than 25 percent of flow at best efficiency point and minimum head, without cavitation and in accordance with vibration criteria specified herein.

C. Each complete pumping unit with motor shall be capable of safely operating at up to 125 percent of full load speed in reverse rotation without sustaining damage.

D. Performance Criteria:
   1. Pumps shall comply with the following minimum conditions:

Design Conditions	Description / Value
Location	West High Service Pump Station
Use	High Service Pump
Fluid Pumped	Finished Water
Number of Pumps Required	2
Number of Stages per Pump	3
* Design Flow (1st design point) (gpm)	3473
* Design Total Head (1st design point) (ft)	225
Minimum Bowl Efficiency at Design (1st design point) (percent)	80
**Motor (Hp)	300
Max Operating Speed (rpm)	1800
Max Sphere Diameter (in)	1.25
Pump Column Diameter (in)	12
Discharge Nozzle Dia. (in)	12
** Available NPSH at Design (1st design point) (ft)	32
*** Flow at 2nd Design Point (gpm)	4000
Total Head at 2nd Design Point (ft)	148
Head at Zero Flow (ft)	370 – 400
Type of Lubrication (water or oil)	Water

Design Conditions	Description / Value
Maximum Liquid Elev. in Suction Well (ft)	19
Minimum Liquid Elev. in Pump Can (ft)	As shown on Contract Drawings
Bottom Elevation of Pump Can (ft)	As shown on Contract Drawings
Pump Discharge Centerline Elevation (ft.)	As shown on Contract Drawings
Solids Content of Pumped Fluid (percent)	None
Fluid Temperature (degrees F)	32 – 120
Fluid pH	7 – 8
Drive Type	Constant Speed
**** Maximum Motor Size (hp)	300
Motor Voltage/Phase/Hertz	460V / 3ph / 60hz

* At maximum speed. Does not include entrance, pump, column, and discharge head losses. The duty point shall be shown on an HI Level 1U curve.

** Required NPSH shall be for size impeller furnished. If impeller is trimmed, provide the curve for the impeller as trimmed.

*** Flow at the 2nd Design Point total head shall be within ten percent of value specified.

**** Pump horsepower requirements shall not exceed stated horsepower at all points on pump curve.

2.2 MANUFACTURERS

A. Manufacturers:
   1. Provide vertical lineshaft pump by one of the following manufacturers.
      a. Flowserve
      b. Patterson
      c. Peerless - Grundfos
   2. Provide motors manufactured by one of the following:
      a. U.S. Motors.
      b. TECO Westinghouse.
      c. General Electric.
      d. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
   1. Pump shall be ANSI/NSF 61 certified.
   2. Pump Base: Provide base of high-grade cast-iron or fabricated steel for mounting driver and supporting pump column. Surface discharge outlet shall be flanged. Flanges shall be ANSI B16.1, Class 125.
   3. Pump Bowls: Castings shall be of close-grained cast-iron smooth and free of casting imperfections, conforming to ASTM A48/A48M. Bowls shall include a 416 SS Wear Ring.
   4. Impellers: Impellers shall be Type 316 SS of semi-open or enclosed type, statically and dynamically balanced. Securely fasten impeller to shaft with keys. Impellers shall include a 416 SS Wear Ring. The bowl (casing) wear ring shall be at least 50 BHN harder than the

impeller wear ring. Impellers shall be balanced to ISO 1940 G2.5 or better. A certified Mill Test Report (CMTR) shall be provided on the impellers.

5. Pump Shafts: Shall be Type 416 SS not less than 12 percent chromium, heat-treated, ground, and polished. Shaft diameter shall be sized for total axial thrust and weight of all rotating parts supported by shaft and horsepower transmitted. Maximum combined shear stress shall not exceed 30 percent of elastic limit in tension or be more than 18 percent of ultimate tensile strength of shafting material.
6. Line Shafts: Provide open line shafts made of Type 416 SS. Surface finish shall not exceed RMS 40. Line shafts shall be furnished in lengths not greater than ten feet with ends faced squarely for perfect alignment after installation. Shafting shall be coupled with steel couplings, designed with a safety factor of 1.5 times shaft safety factor and be left-hand thread to tighten during pump operation. Provide shafts with a non-corrosive wearing surface of hard chrome plated steel at location of each guide bearing.
7. Line Shaft Bearings: Line shaft bearings shall be water lubricated and mounted in bearing retainers held in position in column couplings by means of butted ends of column pipes. Bearings shall be made of bronze alloy C89835. Locate bearings at intervals of no more than 10 feet. Conform to applicable standards of ABMA.
8. Discharge Column Pipe: Column pipe shall be standard inside diameter, at least 12-inch diameter and shall have flanged end connections. Pipe shall be furnished in sections of nominal 10-ft lengths (maximum) and be interchangeable. Frictional headloss in the column shall not exceed five feet of head per 100 feet of length, at pump's rated capacity.
9. Discharge Head Assembly: Provide discharge head assembly with a shaft-packing box. Steel shafting passing through packing boxes shall be stainless steel. Head shaft shall be suitable for reversing ends to renew stuffing box wearing surface. Provide a water pre-lubrication connection at stuffing box, designed to distribute water around shaft for proper lineshaft bearings lubrication before pump start-up.
    a. Provide water-flushed mechanical seal type as specified below:
        1) Split seal, Model 442, by Chesterton.
        2) Seal shall have carbon stationary face and silicon carbide rotary face.
        3) Rotating metal parts shall be Type 316L stainless steel.
        4) Provide needle valve and pressure gage on stuffing box inlet. Provide Type L copper piping to convey flushing water discharge to approved drain location.
10. Provide removable, adjustable, water slinger fitted to pump shaft to prevent pressurized leakage from stuffing box from entering motor enclosure.
11. Strainer: Provide inlet to suction bell with a stainless steel cylindrical shaped strainer with a net inlet area of two times the suction inlet area to the impeller section.
12. Provide anchorages and inserts under this Section. Anchorages and inserts shall be sized and installed per pump manufacturer's recommendations.
13. Bolts, nuts, and cap screws shall have hexagon heads.
14. Attach to pump brass or stainless-steel nameplates giving manufacturer's name, model, and serial number, pump rated capacity, head, speed and other pertinent data.
15. Each pump head flange and each suction barrel flange shall be drilled at a matched location on one side of pump discharge head. Set of drilled holes is for installing a vent pipe to purge air that may accumulate in barrel with varying water levels. Hole shall be 1-inch diameter. Pump head flange hole shall be tapped and provided with a plug on the top side of the

flange. Suction barrel flange shall be tapped and provided with a 1-inch diameter stainless steel pipe extending not less than eight inches down into barrel.

16. Pump supplier shall provide a fabricated steel suction barrel for each pump in accordance with 40 05 24.23 Steel Process Pipe specification. Provide flanged inlets in each barrel at elevations shown on the Contract drawings. Each barrel shall have a minimum wall thickness of 0.5 inches and shall have flow straightening or vortex suppressing vanes installed on the interior face of the barrel. The design of these vanes shall be provided by the pump manufacturer. Provide a suitable gasket to prevent leakage from mounting flange. Conform to ANSI/HI 9.8.

B. Motors:
   1. Provide motor in accordance with Section 40 05 93, Common Motor Requirements for Process Equipment.
   2. The motor shall be inter-changeable with the motor of the existing Pump No. 3 at the West High Service Pump Station. The motor submittal for Pump No. 3 is provided as Attachment A of this specification section for reference.

2.4 ANCHORAGE DEVICES

A. Provide anchorages and fasteners of Type 316 stainless steel of ample size and strength for purpose intended, sized by equipment manufacturer.

2.5 SHOP PAINTING

A. Clean and prime coat ferrous metal surfaces of products in shop in accordance with manufacturer's recommendations.

B. Coat machined, polished, and non-ferrous metal surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and through start of equipment operation.

2.6 LUBRICANTS

A. Provide lubricants, oil, and grease as required for initial operation. Products shall be as recommended by manufacturers of pump and motor.

2.7 SOURCE QUALITY CONTROL

A. Pump Shop Tests: Shop test each pump as follows:
   1. Hydrostatically test pump column and discharge head to twice discharge head or 1.5 times pump shutoff head, whichever is greater, per ANSI/HI 14.6.
   2. Performance Test:
      a. Pump bowls, strainer, job pump head, and job motor shall be performance tested in pump manufacturer's factory. Pump manufacturer shall provide pump column, lineshaft, and other equipment and material required for performance test.

b. At least four weeks prior to scheduled pump performance test, pump manufacturer shall furnish ENGINEER with proposed test procedure. Proposed test procedure shall set forth:
   1) Pump speeds at which performance test will be run.
   2) Sample calculations illustrating how the head/capacity performance curves at full speed will be calculated from test readings.
   3) Conversion factors or tables that relate test instrument readings to quantities being measured.
   4) Description of proposed testing facility, including diagrams of equipment and proposed test set-up and list of instruments to be used in test. All instruments shall be calibrated within one year prior to test. Provide certification of instrumentation calibration if requested by ENGINEER.
   5) Limitations of test stand and proposed deviations from ANSI/HI 14.6.

c. Assemble at pump manufacturer's factory the pump with number of bowls required, strainer, at least one length of column and shaft, pump discharge head, and driver for performance tests. Performance test shall be in accordance with ANSI/HI 14.6 and ANSI/HI 9.6.5.

d. For shop performance tests, operate pump for at least thirty minutes at rated condition before recording data.

e. Operate pump assembly from zero to maximum capacity as shown on pump curve included in approved Shop Drawing. Results of performance test shall be shown on a plot of test curves showing head, flow, brake horsepower, bowl efficiency, current, and net positive suction head required. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design points, and minimum head at which pump is designed to operate.

f. Conduct performance tests within plus-or-minus five percent of design maximum speed and capacity. No minus tolerance is allowed with respect to capacity, total head, and specified efficiency at design point. For adjustable speed pumps, run performance test at full load speed, and derive a family of curves from test data. Family of curves shall be for speeds from 40 to 100 percent of full load speed.

g. Each test shall be witnessed by a registered, licensed professional engineer who may be an employee of pump manufacturer. Registered professional engineer shall sign and seal all copies of test curves and certify that hydrostatic tests were performed. Professional engineer's certification shall show the state of the professional engineer's registration and registration number. Professional engineer's name on seal shall be legible.

h. Provide to ENGINEER certified raw and reduced test data and curves covering each performance test within 14 days after completing performance test. Provide number of copies of test results specified for Shop Drawings. Include with submittal of performance test report the results of hydrostatic tests and copy of approved test procedure.

B. Evaluation of Pump Shop Test Results and Non-conforming Products:
   1. Obtain ENGINEER's approval of shop test results prior to shipping pumps from factory.
   2. Evaluation of pump shop test results will consider the following: conformance with requirements and intent of the Contract Documents; conformance with specified head,

flow, and efficiency at design point specified for each pump, conformance to ANSI/HI 14.6, and estimated annual operating and maintenance cost.

3. There shall be no minus tolerance with respect to capacity, total head, and bowl efficiency at design point condition. Pump performance shall be within tolerances specified in ANSI/HI 14.6.
4. An increase in horsepower at specified conditions when complying to the plus tolerances for head or capacity may be allowed by ENGINEER provided that motor remains non-overloading at all points of operation on head capacity curve from shut-off to minimum head without using motor service factor.
5. Performance test results will be basis for determining whether each pump, in combination with its test driver meets specified minimum efficiencies.
6. If the specified performance is not met, modify the equipment and repeat the performance test at no additional cost to OWNER, until full compliance with specified performance is demonstrated. All costs incurred by OWNER for re-testing to ensure compliance with the Contract Documents, including OWNER's and ENGINEER's time and out-of-pocket costs required for re-testing, will be deducted from money due to the pump manufacturer.
7. The pump manufacturer shall complete all modifications and re-testing within a period sixty days from date of transmittal of ENGINEER's review comments on first set of shop test results.
8. If specified performance requirements are still not met after modifications and two successive, unsuccessful tests by pump manufacturer, OWNER may, at its option, institute one of the following:
    a. Allow additional time for the pump manufacturer to modify and re-test equipment.
    b. Reject the pumping equipment.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which products are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install products in conformance with governing codes, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.

B. Anchorages and Baseplates or Soleplates:
    1. Install pumps on concrete bases. Provide anchorages in new or existing concrete, as applicable, per equipment manufacturer's recommendations and the Contract Documents. Equipment manufacturer shall supply templates to facilitate location of anchorages for equipment. CONTRACTOR shall coordinate with Supplier and equipment manufacturer to assure timely receipt of required templates.
    2. Pour concrete bases up to one inch below equipment baseplate or soleplate as applicable.

Base with equipment mounted thereon or soleplate shall then be accurately shimmed to grade and spaces between filled with non-shrink grout per Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2-inch and the edges neatly finished with 1 to 2 cement mortar.

3. Pump supplier shall be responsible to perform pre-grout leveling of the sole plate for each pump and rechecking the levels after grout has been injected between the sole plate and the concrete base by the Contractor. The post-grout leveling of the sole plate shall be done to a tolerance of 0.002 inches per foot.

C. General:
   1. Conform to ANSI/HI 2.4.
   2. Perform all drilling and fitting required for installation. Set the products accurately in location, alignment, and elevation, plumb and true.
   3. Fit exposed connections accurately together to form tight hairline joints.
   4. Provide 1-inch diameter hard copper pipe from each pump to convey water to drainage inlet.
   5. Provide utility connections per the Contract Documents. Verify that utilities and valves are tested and operational before placing equipment into operation. Connection of discharge nozzle to piping shall conform to ANSI/HI 9.6.2.
   6. Align and adjust equipment including shafting, motors, drives, and piping in presence of ENGINEER
   7. Install for initial operation lubricants recommended by equipment manufacturer
   8. Prior to energizing motor driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.

D. Field painting shall conform to Section 09 91 00, Painting.

E. Conform to Section 01 75 00, Starting and Adjusting.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Following installation, the equipment supplier shall conduct operating tests of all equipment, functions, and controls at the Site in presence of ENGINEER. Should tests result in malfunction, make necessary repairs, revisions, and adjustments and restart test from the beginning. Repeat tests and repairs, revisions, and adjustments until, in opinion of ENGINEER, installation is complete, and equipment is functioning properly and accurately, and is ready for permanent operation.
   2. Field Vibration Tests:
      a. Provide services of an expert in the field of vibration analysis and control with qualifications acceptable to ENGINEER for conducting vibration tests following installation of pumps and prior to start-up.
      b. Vibration testing and criteria for acceptance shall be per ANSI/HI 9.6.4.
      c. Obtain vibration measurements at pump's upper motor bearing while operating over its speed range. Obtain measurements in each of two orthogonal horizontal

directions, one of which shall be in plane of greatest vibration and in vertical (pump axial) direction.

d. Submit to ENGINEER report of successful vibration tests.

3. Field Operating Test:
   a. Field test equipment and its controls in local mode, followed by demonstrating proper operation and controls in remote manual mode. Demonstrate that each part and component of system individually and all parts and components together function properly in manner intended. Total duration of testing shall be 4 hours, continuous and uninterrupted, in remote manual mode. All testing equipment and manpower shall be by the pump supplier.
   b. Comply with applicable provisions of ANSI/HI 9.6.5.
4. Airborne Sound Test: If directed by ENGINEER, perform testing for airborne sound from pump per ANSI/HI 9.4 and IEEE 85.

B. Manufacturer's Services: Provide a qualified, factory trained serviceman to perform the following:
   1. Supervise unloading and installation of equipment.
   2. Instruct CONTRACTOR in installing equipment.
   3. Inspect and adjust equipment after installation and ensure proper operation.
   4. Test-operate the products in presence of ENGINEER and verify that equipment conforms to Contract Documents.
   5. Instruct OWNER's personnel in operating and maintaining the products.
   6. Manufacturer's representative shall make a minimum of 4 visits, with a minimum of 6 hours onsite for each visit. First visit shall be for unloading supervision and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
   7. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products. Training requirements, duration of instruction, and other qualifications shall be per Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   8. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to Site shall be included in the Contract Price.

+ + END OF SECTION + +

ATTACHMENT A

NIDEC MOTOR CORPORATION
8050 WEST FLORISSANT AVE.
ST. LOUIS, MO 63136

DATE: 1/6/2021

P.O. NO.: 487692
Order/Line NO.: 20201318 SO 100

TO: ODESSA PUMPS AND EQUIPMENT INC
PO BOX 60429
MIDLAND, TX, 79711-0429
ATTN: MARK WILLIAMS

Model Number: NA
Catalog Number:
End Of Configuration
LLC,LAST SCREEN

REVISIONS:
A)

ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

Features:

HOLD PRODUCTION
Horsepower ..... 00300.00~00000.00 ~ KW: 223.8
Enclosure ..... WPI
Poles ..... 04~00 ~ RPM: 1800~0
Frame Size ..... 447~VP
Phase/Frequency/Voltage.. 3~060~460
Winding Type ..... Random Wound
Service Factor 1.15
Insulation Class ..... Class "F" ~ VPI-2000
Altitude In Feet (Max) .. 3300 Ft.(1000 M)
Ambient In Degree C (Max) +50 C
Efficiency Class ..... Premium Efficiency
Application ..... Vertical Centrifugal Pump
Customer Part Number ....
16.5" Base
Non-Reverse Ratchet
Pricebook Thrust Value (lbs).. 9800
Customer Down Thrust (lbs) ... 4950
Customer Shutoff Thrust (lbs).
Up Thrust (lbs): ~
"AK" Dimension (Inches).. NA
Shaft Dimensions:~U=2.125 ~ AH/V=4.500
KEYWAY=0.500 ~ ES=3.030
Temperature Rise (Sine Wave): "B" Rise @ 1.0 SF (Resist)
Design Letter ..... B
Starting Method ..... Direct-On-Line Start
Duty Cycle ..... Continuous Duty
Efficiency Value ..... 95.8 % ~ Typical
Load Inertia: NEMA ~ Standard Inertia: 1197 LB-FT2
Number Of Starts Per Hour: NEMA
Motor Type Code RVS4
Rotor Inertia (LB-FT²) 68.3 LB-FT²
Qty. of Bearings PE (Shaft) 1
Qty. of Bearings SE (OPP) 1
Bearing Number PE (Shaft) 6215-J
Bearing Number SE (OPP) 7322 BEM

NIDEC MOTOR CORPORATION

8050 WEST FLORISSANT AVE.
ST. LOUIS, MO 63136

DATE: 1/6/2021

P.O. NO.: 487692
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REVISIONS:
A)

ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

Accessories:

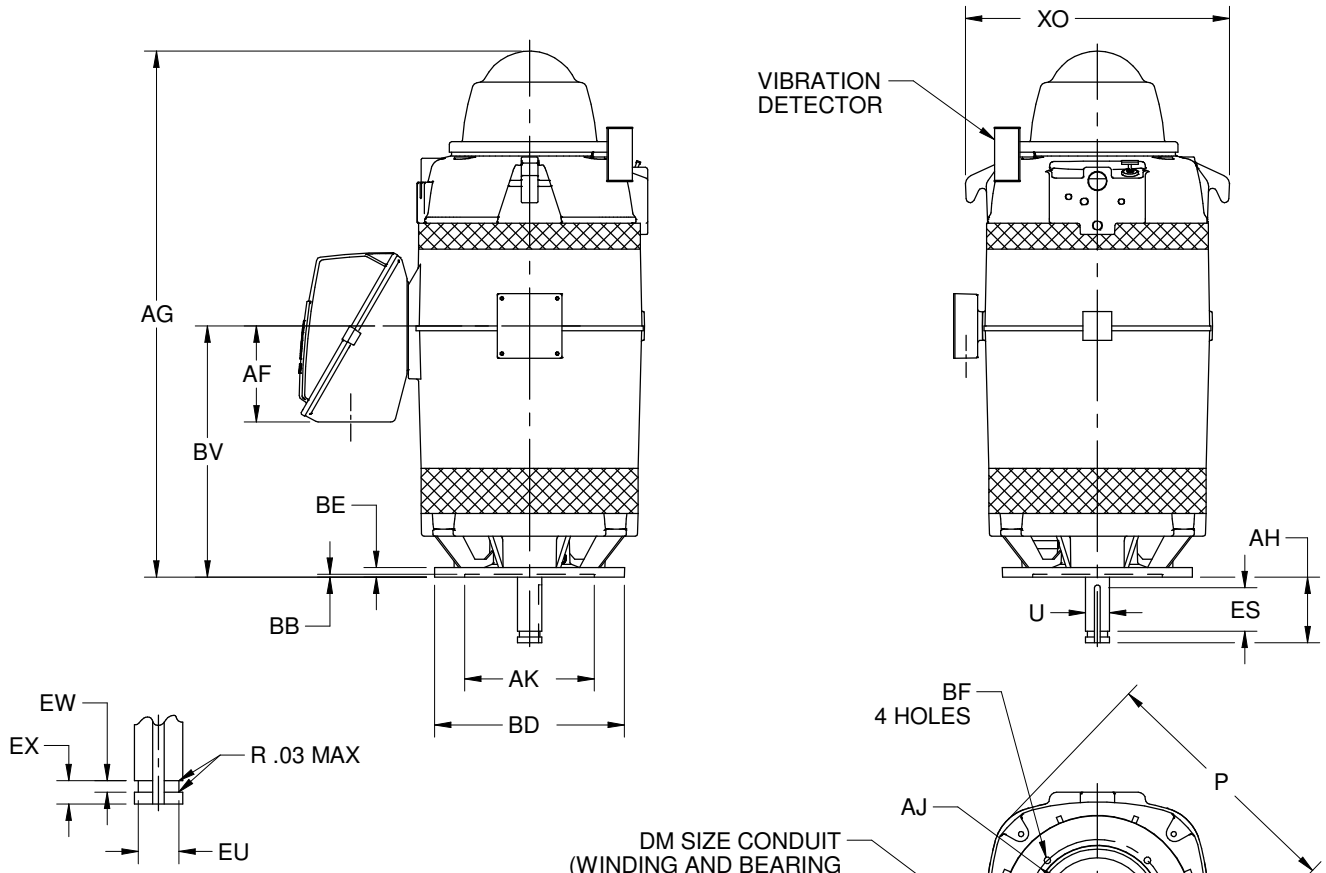
100,000 Hours L-10 Brg. Life
Shaft Slinger - Pulley End
Counter CW Rotation FODE
Ground Lug In Conduit Box
Inpro/Seal Ground Ring CDR
Insul. Bearing - Upper Bracket
12 Inch (1 Foot) Leads
115 Volt Space Heaters
Special Balance
Synthetic Lubrication
Special Features Plate
Dual Element 100 Ohm RTD
Both Bearings
Winding RTD's-100 Ohm,3 Lead
Rotor Epoxy Paint
Conduit Box Information: ~ Size 2.5 - Cast Iron
Conduit Opening Size (AA) .. 3.5" NPT
1 Conduit Opening ~ Bottom Of Conduit Box
Special Features Plate Info:
KVAR RATING
Metrix Velometer -
Q-1 Upper/Short End Bracket
Std. Mounting Position
No Vib Detect On Lower/PE Brk
Q-1 Accessory Outlet Box
Accessory C/B 1 Info:
Outlet Box Material Cast Iron Box
Location Of Accessory Box Same Side As Main O/B
1" NPT Conduit Opening
With Terminal Board
Pre-wired Accessories
100 OHM RTD~SPACE HEATER~100 OHM RTD BRG~~
Renewal/Spare Parts Details:
SPARE 440DR VIB DET.
QTY-2 SPARE 100 OHM
BTD
Test Requirements:
Short Commer. Test - Unwit
Complete Initial Test-Unwit.
Sound Test - Unwitnessed
Vibration Test-Unwit. (IPS)

USE THE DATA PROVIDED BELOW TO SELECT THE APPROPRIATE DIMENSION PRINT

Horsepower	300
Pole(s)	04
Voltage(s)	460
Frame Size	447VP
Shaft U Diameter	2.125

Outlet Box AF	10.00
Outlet Box AA	3.5
Accessory Conduit Box 1 DM	1

EFFECTIVE: 13-APR-20	**DIMENSION PRINT** **WEATHER PROTECTED TYPE I** **FRAME: 447VP, VPA, VPB** **BASIC TYPE: RV4**	PRINT: 09-2629-11
SUPERSEDES: NEW		SHEET: 1 OF 1



ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS

	FRAME	UNITS	BD MAX
	447VP	IN	16.50
		MM	419
	447VPA	IN	20.00
		MM	508
	447VPB	IN	24.50
		MM	622

	AA
	3 NPT
	3 1/2 NPT
	4 NPT

	DM
	3/4 NPT
	1 NPT
	1 1/2 NPT

	UNITS	P [2]	AB	AC	AF	AG	AJ
	IN	26.94	24.25	18.75	10.00	55.00	14.750
	MM	684	616	476	254	1397	374.65

	UNITS	AK +.005	BB MIN	BE	BF	BV	EW +.002	EX -.005	XO
	IN	13.500	.25	1.00	.69	26.19	.375	.750	27.50
	MM	342.90	6	25	18	665	9.53	19.05	699

		4-POLE	6-POLE	8-POLE & SLOWER	UNITS	U -.001	AH ±.063	ES MIN	EU -.005	SQ KEY
	HP	300 & DOWN	200 & DOWN	ALL	IN	2.125	4.50	3.00	1.750	.500
					MM	53.98	114.30	76	44.45	12.70
		350 TO 400	250	- - -	IN	2.375	5.00	3.50	2.000	.625
					MM	60.33	127.00	89	50.80	15.88

1. DIMENSIONS MAY VARY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
2. LARGEST MOTOR WIDTH.
3. TOLERANCES SHOWN ARE IN INCHES ONLY.

09-2629/A

Nidec Motor Corporation
St. Louis, Missouri

ISSUED BY: R. KING
APPROVED BY: C. BUCKLEY

IHP_DP_NMCA (MAR-2011) SOLIDEDGE

NAMEPLATE DATA

CATALOG NUMBER:				NAMEPLATE PART #:	422703-007		
MODEL		FR	447VP	TYPE	RVS4	ENCL	WPI
SHAFT END BRG	6215-J - QTY 1			OPP END BRG	7322 BEM - QTY 1		
PH	3	MAX AMB	50 C	ID#	(ref: Order#: 20201318, Type: SO, Line#: 100)		
INSUL CLASS	F	Asm. Pos.		DUTY	CONT		

HP	300	RPM	1785	HP		RPM	
VOLTS	460			VOLTS			
FL AMPS	331.0			FL AMPS			
SF AMPS	383.0			SF AMPS			
SF	1.15	DESIGN	B	CODE	G		
NEMA NOM EFFICIENCY	96.2	NOM PF	88.7	KiloWatt	223.80		
GUARANTEED EFFICIENCY	95.4	MAX KVAR	46.5	HZ	60		

SF		DESIGN		CODE			
NEMA NOM EFFICIENCY		NOM PF					
GUARANTEED EFFICIENCY		MAX KVAR		HZ			

HAZARDOUS LOCATION DATA (IF APPLICABLE):

DIVISION		CLASS I		GROUP I	
TEMP CODE		CLASS II		GROUP II	

VFD DATA (IF APPLICABLE):

VOLTS		AMPS	
TORQUE 1		TORQUE 2	
VFD LOAD TYPE 1		VFD LOAD TYPE 2	
VFD HERTZ RANGE 1		VFD HERTZ RANGE 2	
VFD SPEED RANGE 1		VFD SPEED RANGE 2	
SERVICE FACTOR		FL SLIP	
NO. POLES	4	MAGNETIZING AMPS	68.6
VECTOR MAX RPM		Encoder PPR	
Radians / Seconds		Encoder Volts	

TEAO DATA (IF APPLICABLE):

HP (AIR OVER)		HP (AIR OVER M/S)		RPM (AIR OVER)		RPM (AIR OVER M/S)	
FPM AIR VELOCITY		FPM AIR VELOCITY M/S		FPM AIR VELOCITY SEC			

ADDITIONAL NAMEPLATE DATA:

Decal / Plate	WD=499495	Customer PN	
Notes		Non Rev Ratchet	NRR
Max Temp Rise	70C RISE/RES@1.00SF	OPP/Upper Oil Cap	5.50 QT/5.2 L
Thermal (WDG)	OVER TEMP PROT 2	SHAFT/Lower Oil Cap	GREASE
Altitude		Usable At	
Regulatory Notes		Regulatory Compliance	
COS		Marine Duty	
Balance	0.08 IN/SEC	Arctic Duty	
3/4 Load Eff.	96.5	Inrush Limit	
Motor Weight (LBS)	2100	Direction of Rotation	
Sound Level		Special Note 1	KVAR RATING
Vertical Thrust (LBS)	9800	Special Note 2	
Thrust Percentage		Special Note 3	
Bearing Life	100K	Special Note 4	
Starting Method		Special Note 5	
Number of Starts		Special Note 6	
200/208V 60Hz Max Amps		SH Max. Temp.	
190V 50 hz Max Amps		SH Voltage	SH VOLTS=115V
380V 50 Hz Max Amps		SH Watts	SH WATTS=192W
NEMA Inertia		Load Inertia	
Sumpheater Voltage		Sumpheater Wattage	
Special Accessory Note 1	BEARING SET POINTS	Special Accessory Note 16	
Special Accessory Note 2	ALARM= 120C	Special Accessory Note 17	AFFIX N/P 915592
Special Accessory Note 3	SHUTDOWN= 130C	Special Accessory Note 18	
Special Accessory Note 4		Special Accessory Note 19	
Special Accessory Note 5		Special Accessory Note 20	
Special Accessory Note 6		Special Accessory Note 21	
Special Accessory Note 7		Special Accessory Note 22	
Special Accessory Note 8		Special Accessory Note 23	
Special Accessory Note 9		Special Accessory Note 24	WINDING SET POINTS
Special Accessory Note 10		Special Accessory Note 25	ALARM= 160C
Special Accessory Note 11		Special Accessory Note 26	SHUTDOWN= 165C
Special Accessory Note 12		Special Accessory Note 27	AFFIX N/P 839471
Special Accessory Note 13		Special Accessory Note 28	
Special Accessory Note 14		Special Accessory Note 29	
Special Accessory Note 15		Special Accessory Note 30	
Heater in C/B Voltage		Heater in C/B Watts	
Zone 2 Group		Division 2 Service Factor	
Note 1		Note 2	
Note 3		Note 4	
Note 5		Note 6	
Note 7		Note 8	
Note 9		Note 10	
Note 11		Note 12	
Note 13		Note 14	
Note 15		Note 16	
Note 17		Note 18	
Note 19		Note 20	
Note 21		Note 22	

NIDEC MOTOR CORPORATION
ST. LOUIS, MO

TYPICAL NAMEPLATE DATA
ACTUAL MOTOR NAMEPLATE LAYOUT MAY VARY
SOME FIELDS MAY BE OMITTED

MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
NA	NA	3	RVS4	447VP

ORDER NO.	20201318	LINE NO.	100

MPI:	93202
HP:	300
POLES:	4
VOLTS:	460
HZ:	60
SERVICE FACTOR:	1.15
EFFICIENCY (%):	
S.F.	95.5
FULL	95.8
3/4	96.5
1/2	96.4
1/4	94.7
POWER FACTOR (%):	
S.F.	88.2
FULL	88.7
3/4	88.2
1/2	84.7
1/4	70.2
NO LOAD	4.8
LOCKED ROTOR	20
AMPS:	
S.F.	383
FULL	331
3/4	248
1/2	172
1/4	106
NO LOAD	68.6
LOCKED ROTOR	2200
NEMA CODE LETTER	G
NEMA DESIGN LETTER	B
FULL LOAD RPM	1785
NEMA NOMINAL / EFFICIENCY (%)	96.2
GUARANTEED EFFICIENCY (%)	95.4
MAX KVAR	46.5
AMBIENT (°C)	50
ALTITUDE (FASL)	3300
SAFE STALL TIME-HOT (SEC)	21
SOUND PRESSURE (DBA @ 1M)	85
TORQUES:	
BREAKDOWN{% F.L.}	175
LOCKED ROTOR{% F.L.}	80
FULL LOAD{LB-FT}	883.6

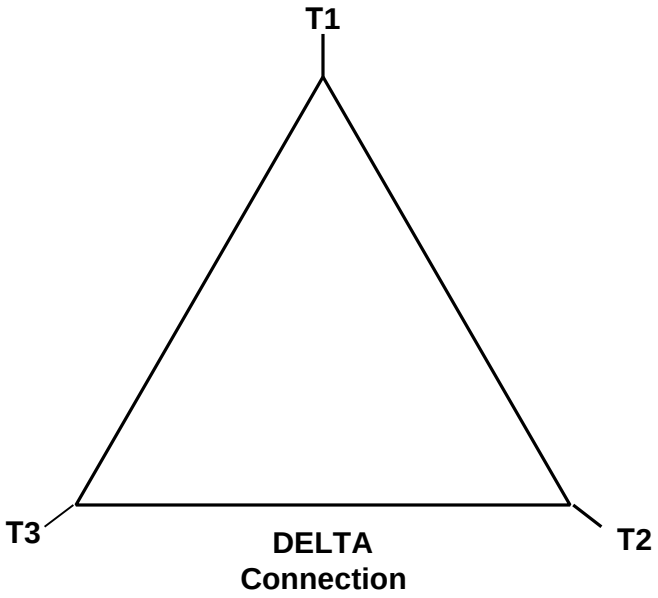
NEMA Nominal and Guaranteed Efficiencies are up to 3,300 feet above sea level and 25 ° C ambient

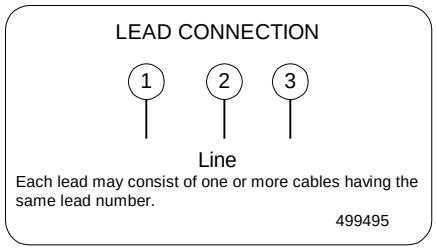
The Above Data Is Typical, Sinewave Power Unless Noted Otherwise

NIDEC MOTOR CORPORATION
ST. LOUIS, MO

499495

Motor Wiring Diagram





To reverse direction of rotation interchange connections L1 and L2.
Each lead may be comprised of one or more cables.
Each cable will be marked with the appropriate lead number.

EFFECTIVE: 2/27/96
SUPERCEDES: X736618, 96441, 179879, 284138
Connection Plate: 499495
Connection Decal: 912113

Acc. Wiring Diagram 1

2091171

The information you have requested is currently not available electronically.
Please contact your USEM Customer Service Representative or call 1-888-637-7333.

ST5484E Seismic Velocity 4-20 mA Transmitter

Datasheet

OVERVIEW

The ST5484E is a self-contained seismic velocity transmitter that incorporates a piezoelectric accelerometer, signal integrator, RMS peak detector, and a 4-20 mA signal conditioner into a single package. It can be mounted directly on a machine case or bearing housing without intervening signal conditioning equipment. The amplitude of the integrated acceleration (velocity) signal is converted to a proportional 4-20 mA signal compatible with industrial process control instrumentation such as PLCs, DCSs, and SCADA systems that can provide trending and/or alarming capabilities for a simplified vibration monitoring strategy.

When the flying lead or terminal block connector options are chosen, the transmitter does not need a separate environmental housing and can directly accept conduit. To reduce installed cost, it can be used with barriers for intrinsically safe installations, or wired directly to explosion-proof conduit fittings for explosion-proof installations.

Need A Local Display?

When continuous, local indication of vibration levels is required at the transmitter, the Metrix ST5491E provides these capabilities. Its sensing and transmitter elements are similar to the ST5484E, but it includes a convenient 2½ digit LCD display in an integral conduit elbow and is rated for use in temperatures from -10°C to +70°C. Refer to Metrix datasheet 1004598 for ordering information and detailed specifications.

Flying Leads
(Option D=0, 1, 5, or 6) (2-wire shown; 4-wire also available)

2-Pin Terminal Block
(Option D=2)

4-Pin Terminal Block
(Option D=3)

2-Pin MIL Connector
(Option D=4)

Explosion Proof Versions with Options D=2 & 3

Note: Units sold with an explosion proof rating will include an 8200-000 IEC explosion proof elbow that will be affixed at the factory.

APPLICATIONS

A vibration transmitter may be appropriate in applications where a stand-alone monitoring system may not be warranted.

The ST5484E handles general-purpose vibration measurements on a wide range of rotating and reciprocating machinery with rotative speeds between 120- and 6,000-rpm. Seismic measurements are suitable for machines with rolling-element bearings because shaft vibration in such machines is usually transmitted directly through the bearing to the bearing housing without substantial damping or attenuation. Seismic transducers can also measure vibration that does not originate at the shaft, such as bearing-related wear and defects, footing/foundation problems, piping resonances that are coupled to the machine, etc.

Why Measure Velocity?

Acceleration and displacement levels are heavily influenced by the frequencies at which the vibration is occurring, while velocity levels are much less influenced. Thus, although acceleration, velocity, and displacement measurements are inter-related mathematically, seismic velocity measurements tend to be more consistent over a wide range of frequencies than either displacement or acceleration. Consequently, broadband (sometimes called "overall" or "unfiltered") velocity measurements are appropriate for monitoring many machines as a reliable indicator of damaging vibratory energy, with the notable exception of machines with fluid-film bearings, which are usually better addressed by shaft-observing proximity probes.

Casing displacement is not a practical measurement to make directly and is typically just an integrated seismic velocity measurement. As such, the primary decision when selecting a seismic sensor will usually be whether to measure casing velocity or casing acceleration. As noted above, casing velocity will often be more appropriate because it tends to be a more reliable indicator of damaging vibratory energy over a broad frequency spectrum for low- to medium-speed machinery.

NOTE: For machines with fluid-film bearings, shaft-observing proximity probes will provide more effective vibration measurements than seismic transducers due to the rotor dynamics of the machine and the attenuation of vibratory energy through a fluid-film boundary. Accordingly, Metrix recommends and provides proximity probes and associated 4-20 mA transmitters or monitoring systems for such applications.

For machines with rolling element bearings and running above 6,000 rpm, and/or where impulsive casing vibration occurs, acceleration may be a better measurement. In such situations, it is recommended that you consult with a Metrix sales professional who can review your application and assist with selection of the proper transducer type and associated transmitter or monitoring system.

FEATURES

- **RFI/EMI Immunity** – Enhanced circuit design and installation techniques aggressively filter out noise from common sources such as handheld radios
- **Excellent Moisture Resistance** – The 2-pin MIL connector version is hermetically sealed to provide an IP67-rated enclosure. Flying lead and terminal block versions are fully potted and rated to IP66 when installed with optional IEC conduit elbow
- **Hazardous Area Approvals** – North American (CSA), Brazilian (INMETRO), and European (ATEX & IEC) approvals available
- **Dynamic Signal Availability** – 2-wire versions provide a 4-20 mA velocity- proportional signal for easy connection to PLCs, DCSs, and other plant control systems. Optional 4-wire versions[1] also provide the raw acceleration signal (100 mV/g) for use with vibration data collectors and analyzers
- **Variety of Connection Options** – Flying leads, terminal block, and MIL-type connectors available
- **Conduit-Ready[2]** – Terminal block and flying lead options have conduit threads on top of sensor. No special housings are required for connection of conduit
- **Rugged, Industrial Design** – Robust construction offers outstanding durability; built-in base and housing strain protection helps ensure that over-torqueing sensor-to- machine and sensor-to-conduit connections won't damage internals or body
- **High- and Low-Pass Filter Options** – The ST5484E can be ordered with a wide variety of low- and high-pass filter options to precisely tailor the band over which vibration is measured
- **Polarity-Independent Wiring** – Metrix patented IPT® technology allows loop power to be connected without regard to voltage polarity, reducing field wiring errors and ensuring that the raw acceleration output[1] is not phase inverted
- **Multiple Mounting Options** – Integral and removable mounting stud options available in both metric and English thread sizes; flat base mounting adapters are also available
- **Loop-Powered** – Runs on nominal 24 V_{DC} power supplied by the 4-20 mA current loop
- **Wide Supply Voltage Range** – Accepts loop power voltages from 11 to 29.6 V_{DC} (intrinsically safe) or 30.0 V_{DC} (explosion proof & non-incendive)
- **RMS Amplitude Detection** – Measures Root Mean Square (RMS) vibration amplitude. Options available for True RMS or scaled RMS (RMS x √2) for "derived peak"
- **Numerous Full Scale Ranges** – The full scale ranges provided in option AAA reflect frequently-ordered ranges; however, many others (too numerous to list) are also available. Consult factory for applications requiring other full scale ranges

Notes:

1. Dynamic raw acceleration signal available with 4-wire versions only (ordering options D= 1 and D=3).
2. Metrix recommends flexible (rather than solid) conduit when possible. Solid conduit can introduce preload forces on the sensor and alter of the vibration response of the sensor.

SPECIFICATIONS

All specifications are at +25°C (+77°F) and +24 V_{DC} supply voltage unless otherwise noted.

Inputs	
Supply Voltage (see also note under max loop resistance)	11 – 29.6 V_{DC} (24 V_{DC} nominal) (intrinsically safe); 11 – 30 V_{DC} (24 V_{DC} nominal) (explosion proof and non-incendive); Metrix patented IPT® independent polarity diode bridge circuit allows voltage to be connected without regard to polarity
Circuit-to-Case Isolation	500 Vrms
Outputs	
4-20 mA	Proportional to velocity full scale range (4mA = 0 vibration, 20mA = full scale vibration)
Maximum 4-20 mA loop resistance	R_L = 50 x (Vs – 11) Ω where Vs = Supply Voltage at transmitter terminals. NOTE: For every 50 Ω of resistance in the 4-20 mA loop, 1 V_{DC} above the minimum supply voltage (11 V_{DC}) must be available at the transmitter terminals. For example, 12 V_{DC} at the transmitter terminals will allow a 50 Ω loop resistance; 30 V_{DC} at the transmitter terminals will allow a 950 Ω loop resistance. For intrinsically safe applications, the use of a passive zener barrier will incur a voltage drop of approximately 8.1 volts at the barrier, and the loop supply voltage is limited to 26 V_{DC}. Thus, with passive barriers and a 26 V_{DC} supply, the maximum available voltage at the transmitter will be 17.9 V_{DC} and the corresponding maximum loop resistance will be 345 Ω.
Dynamic Signal	100 mV/g (10.2 mV / m/s²) acceleration, filtered to same frequency band as proportional velocity (see ordering options E & F)

Dynamic Signal Output Impedance	10 kΩ **NOTES:** 1. The dynamic signal output is short-circuit protected by means of a 10 kΩ resistor, resulting in a relatively large output impedance. Many data collectors and analyzers have relatively low input impedances (100 kΩ or less) which will load this dynamic output and attenuate the signal by 10% or more. Refer to Table 1 for the dB and percentage attenuation for various load impedances. 2. Because the ST5484E is a loop-powered device with low operating power, the dynamic signal output requires a buffer amplifier for cable runs in excess of 16 feet (5 meters). Longer cable runs will also introduce distributed cable capacitance that acts as a low-pass filter, attenuating high- frequency signal content. In such situations, consult the factory for assistance selecting an appropriate low-capacitance cable.
Recommended Minimum Load Impedance (Zload) for Dynamic Signal Connection	500 kΩ (see also note 1 above)
Signal Processing	
Frequency Response (+/- 3dB passband)	2 Hz – 1500 Hz (standard) 2 Hz – 2000 Hz (optional)
Optional High-Pass Filter Corner	5, 10, 20, 50, 100, or 200 Hz (must be specified at time of ordering)
High-Pass Roll-Off	12 dB / octave
Optional Low-Pass Filter Corner	230, 250, 350, 450, 500, or 1000 Hz (must be specified at time of ordering)
Low-pass Roll-Off	12 dB / octave
Accuracy	± 2.5% (within passband) ± 4% (at corner frequencies)
Maximum Full Scale	5.0 in / sec (others by request)
Minimum Full Scale	0.5 in / sec (others by request)
Full Scale Range Units	• in / sec (standard) • mm / sec (available by request)
Amplitude Detection	True RMS detector; full scale may be ordered with True RMS units or scaled RMS (RMS x √2) for "derived peak" measurements See ordering option AAA.

Physical	
Operating Temperature	-40°C to +100°C (-40°F to +212°F)
Weight	0.9 lbs (0.36 kg)
Dimensions	Refer to Figures 1 and 2 on page 8
Sensitive Axis	Same as mounting stud axis
Axis Orientation	Any
Enclosure Material	• 303 stainless steel (standard) • 316 stainless steel (optional)
Enclosure Rating	**MIL-Style Connector (option D=4):** • IP67 and NEMA 4X
	Flying Leads and Terminal Block Connectors (option D≠4): • **IP66** when used with the following conduit elbows: 8200-001-IEC, 8200-003-IEC, 8200-008-IEC, • **No Rating*** when used with the following conduit elbows: 8200-001, 8200-003, 8200-005, 8200-008, 8200-101, 8200-103, 8200-108 * **NOTE:** IP and NEMA ratings pending; refer to table on page 6.
Connector Types	• Flying Leads (2- and 4-wire) • MIL-C-5015 (2-wire only) • Terminal Block (2- and 4-wire)
Humidity	• 95%, non-condensing (flying lead and terminal block versions) • 100% condensing (MIL-style connector)
Approvals	
CE Mark	• Yes
Hazardous Areas	• CSA • ATEX • IECEx • INMETRO • KOSHA • Custom Union EAC
Recommended IS Barriers	
Passive (Zener Type)	MTL 7787+ or equal
Active (Zener Type)	MTL 7706 or equal
Active (Galvanic Type)	MTL 5541 or equal
ST5484E Entity Parameters	• Vmax: 29.6 V_{DC} (intrinsically safe) • Vmax: 30 V_{DC} (explosion proof and non-incendive) • Imax: 100 mA

ORDERING INFORMATION

ST5484E- AAA-BBCD-EF

AAA				Full Scale Range[1]
	1	2	1	1.0 in/sec (25.4 mm/s) peak[2]
	1	2	2	0.5 in/sec (12.7 mm/s) peak[2]
	1	2	3	2.0 in/sec (50.8 mm/s) peak[2]
	1	2	4	5.0 in/sec (127 mm/s) peak[2]
	1	2	6	0.8 in/sec (20.3 mm/s) peak[2]
	1	3	2	3.0 in/sec (76.2 mm/s) peak[2]
	1	5	1	1.0 in/sec (25.4 mm/s) true RMS
	1	5	2	0.5 in/sec (12.7 mm/s) true RMS
	1	5	3	2.0 in/sec (50.8 mm/s) true RMS
	1	5	4	5.0 in/sec (127 mm/s) true RMS
	1	5	6	0.8 in/sec (20.3 mm/s) true RMS
	1	6	2	3.0 in/sec (76.2 mm/s) true RMS

BB		Housing Material & Stud Size[1]
	00	303 SS housing, ¼" NPT stud
	01	303 SS housing, ½" NPT stud
	02	303 SS housing, ⅜ x 24 UNF – ½" stud
	03	303 SS housing, ½ x 20 UNF – ½" stud
	04	303 SS housing, M8 x 1.0 – 12 stud
	05	303 SS housing, M10 x 1.25 – 12 stud
	06	303 SS housing, ¼ x 20 UNC – ½" stud
	07	303 SS housing, ¼ x 28 UNF – ½" stud
	08	303 SS housing, M8 x 1.25 – 12 stud
	09	303 SS housing, ⅜ x 16 UNC – ½" stud
	10	316 SS housing, ¼" NPT stud
	11	316 SS housing, ½" NPT stud
	12	316 SS housing, ⅜ x 24 UNF – ½" stud
	13	316 SS housing, ½ x 20 UNF – ½" stud
	14	316 SS housing, M8 x 1.0 – 12 stud
	15	316 SS housing, M10 x 1.25 – 12 stud
	16	316 SS housing, ¼ x 20 UNC – ½" stud
	17	316 SS housing, ¼ x 28 UNF – ½" stud
	18	316 SS housing, M8 x 1.25 – 12 stud
	19	316 SS housing, ⅜ x 16 UNC – ½" stud
	20	303 SS housing, ½ x 13 UNC – ½" stud
	30	316 SS housing, ½ x 13 UNC – ½" stud

C		Hazardous Area Certification[3,4,5]
	0	No Hazardous Approval Area
	1	CSA US/C, Class I, Div 2, Grps A-D (non-incendive)
	2	CSA US/C, Class I, Div 1, Grps B-D and Class II, Div 1, Grps E-G (explosion proof)
	3	ATEX, Ex ia IIC T4 Ga (intrinsically safe)
	4	CSA US/C, Class I, Div 1, Grps A-D (intrinsically safe)
	5	INMETRO, Ex ia IIC T4 Ga (intrinsically safe)
	6	INMETRO, Ex d IIC T4 Gb (explosion proof)
	7	IECEx/KOSHA Ex ia IIC T4 Ga (intrinsically safe) 16-AV4BO-0214X
	8	ATEX/IECEx/KOSHA Ex d IIC T4 Gb (explosion proof) 16-AV4BO-0213X
	A	EAC, Ex ia IIC T4 Ga (intrinsically safe), Ex d IIC T4 Gb (explosion proof)
	B	ATEX/EAC, Ex ia IIC T4 Ga (intrinsically safe)

D		Connection Type[3]
	0	24" Flying Leads, 2-wire; (4-20 mA output only)
	1	24" Flying Leads, 4-wire; (4-20 mA output and dynamic raw acceleration signal)
	2	Terminal Block, 2-wire[6]; (4-20 mA output only)
	3	Terminal Block, 4-wire[6]; (4-20 mA output and dynamic raw acceleration signal)
	4	2-Pin MIL-Style (MIL-C-5015); (4-20 mA output only)
	5	72" Flying Leads, 2-wire; (4-20 mA output only)
	6	72" Flying Leads, 4-wire; (4-20 mA output and dynamic raw acceleration signal)

E		High-Pass Filter
	0	2 Hz (standard)
	1	5 Hz
	2	10 Hz
	3	20 Hz
	4	50 Hz
	5	100 Hz
	6	200 Hz[7]
	X	Custom (consult factory)[7]

F		Low-Pass Filter
	0	1500 Hz (standard)
	1	500 Hz
	2	1000 Hz
	3	2000 Hz
	4	250 Hz[7]
	5	230 Hz[7]
	6	350 Hz[7]
	7	450 Hz
	X	Custom (consult factory)[7]

NOTES:

1. Smaller-diameter mounting studs are not able to withstand sustained ambient vibration levels above 2.0 in/sec. Consult Table 2 for allowable combinations of A and B options.
2. The ST5484E uses an RMS amplitude detection circuit. Full scale ranges in peak units use scaled RMS (i.e., RMS x √2). The "derived peak" measurements will equal true peak only under the special case of a pure sinusoid, not complex vibration signals.
3. Hazardous Area Certifications are not compatible with all connection types. Consult Table 3 for allowable combinations of C & D options.
4. Some approvals require intrinsic safety barriers, others require Explosion-Proof wiring practices. Refer to Table 4.
5. ATEX/IECEx/INMETRO Ex d (flameproof) approvals (ordering option C=8 or C=6) require conduit elbow 8200-AAA-IEC, sold separately.
6. Refer to the Accessories section of this document. Units sold with an explosion proof rating will include an 8200-000 IEC explosion proof elbow that will be affixed at the factory.
7. High- and Low-Pass filter corners for standard filters must be separated by at least one octave (low-pass frequency must be at least twice the high-pass frequency). All combinations are allowed except E = 6 and F = 4, 5, or 6. Custom filters with closer separation and/or different roll-offs may be available in some instances. Consult the factory if custom filters are required.

Table 1 – Attenuation of Dynamic Signal versus Load Impedance (Z_{load})

Data Collector / Analyzer Load Impedance (Z_{load})	Dynamic Signal Voltage Attenuation (dB)	Dynamic Signal Voltage Attenuation (%)
10 MΩ	0.01 dB	0.1%
5 MΩ	0.02 dB	0.2%
2 MΩ	0.04 dB	0.5%
1 MΩ	0.09 dB	1%
500 kΩ	0.18 dB	2%
200 kΩ	0.43 dB	5%
100 kΩ	0.84 dB	9%
50 kΩ	1.61 dB	17%
20 kΩ	3.57 dB	33%
10 kΩ	6.10 dB	50%

Table 2 – Allowable Combinations for AAA & BB Options

Full Scale Range AAA =	Allowable BB options (Mounting Stud Sizes)
121, 122, 123, 126, 151, 152, 153, 156	All (no restrictions)
124 and 154	00, 01, 03, 10, 11, 13
132 and 162	00, 01, 02, 03, 05, 09, 10, 11, 12, 13, 15, 19

Table 3 – Allowable Combinations for C & D Options

C / D	0	1	2	3	4	5	6	7	8	A	B
0	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4	Y	Y	N	Y	Y	Y	N	Y	N	N	Y
5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 4 – Approvals and corresponding wiring requirements

C	Agency	Approved Areas	I.S. Barriers Required	Explosion-Proof Wiring Required	I.S Barriers or XP Wiring Not Required
1	CSA US/C	Class I, Div 2,Groups A-D (non-incendive)			•
2	CSA US/C	Class I, Div 1, Groups B-D; Class II, Div 1, Groups E-G (explosion proof)		•	
3	ATEX	Ex ia IIC T4 Ga (intrinsically safe)	•		
4	CSA	Class I, Div 1, Groups A-D (intrinsically safe)	•		
5	INMET-RO	Ex ia IIC T4 Ga (intrinsically safe)	•		
6	INMET-RO	Ex d IIC T4 Gb (explosion proof)		•	
7	IECEx / KOSHA	Ex ia IIC T4 Ga (intrinsically safe)	•		
8	ATEX / IECEx / KOSHA	Ex d IIC T4 Gb (explosion proof)		•	
A	EAC	Ex ia IIC T4 Ga (intrinsically safe) Ex d IIC T4 Gb (explosion proof)	•	•	
B	ATEX/ EAC	Ex ia IIC T4 Ga (intrinsically safe)	•		

ACCESSORIES - ELBOWS

Conduit elbows are used with flying leads and terminal block versions of the ST5484E transmitter. They are not compatible with MIL-connector versions of the transmitter. A variety of available configurations accommodate English and metric conduit thread sizes, hazardous area approvals, materials of construction, and IP ratings. Note that not all configurations are available with hazardous area approvals or IP ratings. Consult the ordering information below. For ST5484E's that need an explosion proof (Ex d) rating, that are utilizing flying leads, Option D=0, 1, 5, & 6, the elbows (8200-001, 003, 005, 008, 101, 103, 108 and their IEC counterparts) must be used with a certified junction box or other certified connection location. For ST5484E's that need an explosion proof (Ex d) rating, utilizing integral terminal block, Option D=2 & 3, no junction box is necessary. Table 4 in the datasheet relates what hazardous area (Option C) is allowed per ST5484E Connection (Option D). ST5484E sold with an explosion proof rating (Ex d) will include a 8200-000 IEC explosion proof elbow and will be affixed at the factory.

A A A - B
8200- □□□-□

ELBOWS								
A	**A**	**A**	**B[2,5]**	**Conduit Fitting Size**	**Coating**	**Approvals**	**IP Rating (Elbow)**	**Material**
0	0	0	IEC	1" NPT	Powder	ATEX/IECEx[3,4]	IP66	Copper-free aluminum
0	0	1		¾" NPT	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	1	IEC	¾" NPT	Powder	ATEX/IECEx[3,4]	IP66	Copper-free aluminum
0	0	3		½" NPT	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	3	IEC	½" NPT	Powder	ATEX/IECEx[3,4]	IP66	Copper-free aluminum
0	0	5		½" NPT	None	None	None	303 stainless steel
0	0	8		M20 x 1.5 metric	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	8	IEC	M20 x 1.5 metric	Powder	ATEX/IECEx[3,4]	IP66	Copper-free aluminum
1	0	1		¾" NPT	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum
1	0	3		½" NPT	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum
1	0	8		M20 x 1.5 metric	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum

Stainless steel elbows
(models AAA=005)

Copper-free aluminum elbows
(all models except AAA=005)

8200-000 IEC Reducers		
Part	**Description**	**Material**
91104-032	Reducer, 1"NPT(M) - ¾"NPT(F)	Nickle plated brass
91104-031	Reducer, 1"NPT(M) - ½"NPT(F)	Nickle plated brass
91104-022	Reducer, 1"NPT(M) - M20 X 1.5(F)	Nickle plated brass

NOTES:

1. CSA approved through manufacturer (not Metrix) for the following areas:
   Class I, Div. 1 (Grps C & D)
   Class II, Div. 1 (Grps E, F & G)
   Class III
   UL approved through manufacturer (not Metrix) for the following areas:
   Class I; Div. 1 (Grps. B, C, D)
   Class II; Div. 1 (Grps. E, F, G)
2. B=IEC is only available for AAA=001, 003, and 008 at this time
3. ATEX approved through manufacturer (not Metrix), (B=IEC)
   ITS09ATEX16417U
   Ex II2G, Ex d IIC
   CML 16ATEX1325X
   Ex II2GD, Ex db IIB Gb, Ex tb IIIC Db IP65 minimum
4. IECEx approved through manufacturer (not Metrix)
   IECExITS09.0024U
   Ex d IIC
   IECEx QPS 16.0012X
   Ex db IIB Gb, Ex tb IIIC IP66
5. Elbow 8200-AAA-IEC is required for ST5484E installations meeting ATEX/IECEx/INMETRO/KOSHA/EAC Ex d (flameproof) hazardous area certifications

	Part Number	Description
 NOTE: Dielectric grease must be applied on the rubber boot connector to prevent moisture ingression.	**8978-111-XXXX**	**2-pin MIL Splash-Proof (IP66) Cable Assembly** Used with 2-pin MIL style connector. Cable-to-sensor connection made by means of tight friction fit between cable molded boot and sensor - does not use threads. Connector is fully potted to provide IP66 seal against moisture ingression. 6.4mm (0.25”) diameter polyurethane jacketed cable encapsulates a single twisted pair of conductors and shield. XXX.X = cable length in meters (example: 0035= 3.5 m) Min. cable length: 0.5m (XXXX=0005) Max. cable length: 999.5m (XXXX=9995) **Note:** Must be ordered in increments of 0.5m
	**8978-211-XXXX**	**2-pin MIL Cable Assembly** Similar to 8978-111 but without splash-proof boot and without IP66 rating; identical constraints on XXXX ordering options.
	**8978-200-0000**	**2-pin MIL Connector Assembly** Similar to 8978-211 but without cable (connector can be disassembled for field installation of cable)
	**8978-311-XXXX**	**2-pin MIL Submersible (IP67) Cable Assembly** Similar to 8978-111 but uses overmolded screw-type connector for IP67 rating. 4.9mm (0.19”) diameter polyurethane jacketed cable encapsulates a single twisted pair of 20 AWG conductors and shield. Gold plated contacts, Stainless steel 316L Nut. XXX.X = cable length in meters (example: 0050= 5.0 m) **NOTE:** only 5m, 10m, and 20m lengths available at this time. 5m length stock std; other length may incur longer lead times.
  NOTE: Dielectric grease must be applied on the rubber boot connector to prevent moisture ingression.	**9334-111-XXXX-YYYY** **9334-211-XXXX-YYYY**	**2-pin MIL Splash-Proof (IP66) Cable Assembly With Armor** Used with 2-pin MIL-style connector. Connector is fully potted and provided with integral molded boot to provide IP66 seal against moisture ingression. 7.1mm (0.28”) diameter 304 stainless steel armor encapsulates a single twisted pair of conductors and shield. **2-pin MIL Armored Cable Assembly** Similar to 9334-111 but without splash-proof boot and without IP66 rating; identical constraints on XXXX and YYYY ordering options. XXX.X = armor length in meters (example: 0035= 3.5 m) Min. armor length: 0.5m Max. armor length: 60m Must be ordered in 0.5m increments YYY.Y = cable length in meters Min. cable length: 1.0 Max: 999.5m Must be ordered in 0.5 m increments; **NOTE:** cable length must exceed armor length by at least 0.5 m.
	**8169-75-002-XXX**	**2-wire Cable Assembly** Designed for installations where conduit will not be used to protect field wiring. Fitting mates directly to all 8200 elbows with ¾” NPT reducers. Cable is 2-conductor (20 AWG) twisted, shielded pair in PVC jacket. Cable grip included for strain relief. Material: zinc-plated steel XXX= length in feet (example: 010=10 feet) Min. cable length: 1 foot (001) Max. cable length: 999 feet (999)
	**8201-001**	**Conduit Union** Fits between ST5484E and 8200 conduit elbow when there is not enough room to rotate the elbow. Suitable for Class I, Div 1 (Grps A,B,C,D) and Class II, Div 1 (Grps E,F,G) hazardous areas. Material: zinc-plated steel

	**7084-001**	**Flange Mount Adapter** Adapts ½" NPT mounting stud on ST5484E to 3-hole flat-base pattern. Hole pattern is three equally spaced 0.26" diameter holes on 1.5" diameter circle. Adapter is 2" diameter x 0.75" thick. Material: 303 stainless steel
	7084-002	**Flange Mount Adapter** Same as 7084-001 except center hole adapts ¼" NPT stud on the 5484E.
	7084-005	**Flange Mount Adapter** Same as 7084-001 except center hole adapts ⅜ x 24 UNF stud on the 5484E.
	**8253-002**	**½" NPT to ¼" NPT Reducer Bushing** Adapts ¼" NPT stud on ST5484E (B=0) to ½" NPT mounting hole. Material: 303 stainless steel
	**93818-004**	**Cable Grip Strain Relief Fitting** Used primarily with 8978 cable assemblies where cable enters junction box. ¾" NPT male thread to cable grip. Fits cable diameters from 0.156" to 0.25". Complete with sealing ring and locknut. Hot dip / mechanically galvanized finish. Suitable for NEMA 4 junction boxes.
	**93818-018**	**Cable Grip Strain Relief Fitting** Similar to 93818-004, but fits larger cable diameters from 0.4" to 0.5", such as customer-supplied cables used with terminal block versions of ST5484E (D = 2 or 3).

OUTLINE DIAGRAMS

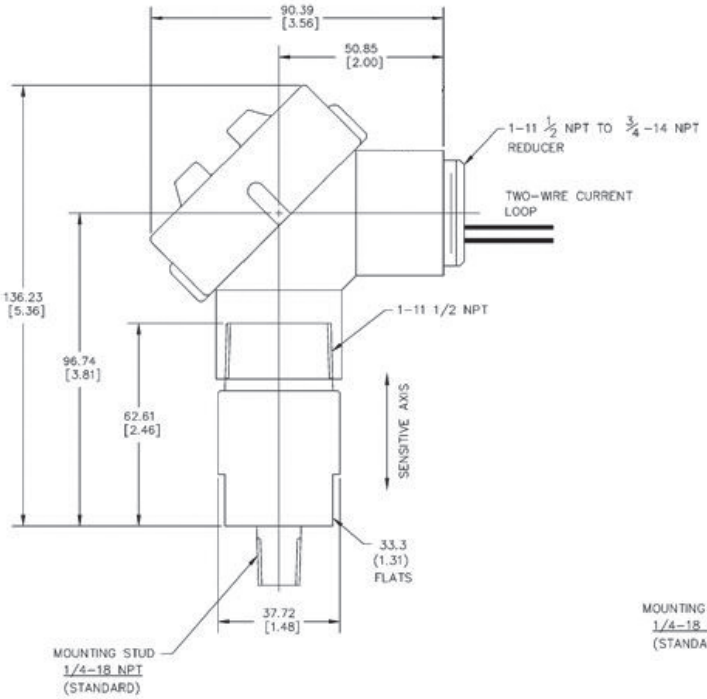
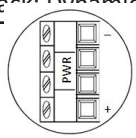


Figure 1: Outline dimensions of the ST5484E (all versions except MIL-Style Connector). Dimensions in mm [inches]. Optional* 8200-001 conduit elbow shown installed.

Figure 2: Outline dimensions of the ST5484E-XXX-XX4-XX (MIL-Style Connector). Dimensions in mm [inches].

* **NOTE:** 8200-AAA-IEC elbow is mandatory for ATEX/IECEx/INMETRO/KOSHA/EAC Ex d (flameproof) approved installations.

WIRING CONNECTIONS

Table 5 – Wiring Connection Legend		
Connector Type	**Dynamic Signal Connections**	**Power Connections**
MIL-C-5015	Not Available	24 V_{DC} power may be connected to all ST5484E models without regard to polarity. Sensor uses IPT® independent polarity diode bridge circuit that will always orient voltage correctly inside sensor, regardless of polarity externally. **NOTE:** Although the ST5484E allows polarity in either direction, installations using I.S. barriers will need to observe correct polarity at the barrier input side. However, the barrier output side (i.e., sensor connection) may be wired without regard to polarity.
2-wire flying leads	Not Available	
2-wire terminal block	Not Available	
4-wire flying leads	Red: Power + Blue: Power - White: Dynamic Signal - Black: Dynamic Signal +	
4-wire terminal block	 NOTE: + AND – SYMBOLS ARE NOT ON LABEL	

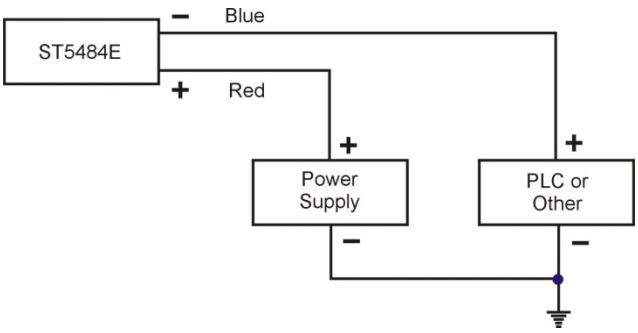


Figure 3: Typical installation for a single ST5484E seismic vibration transmitter.

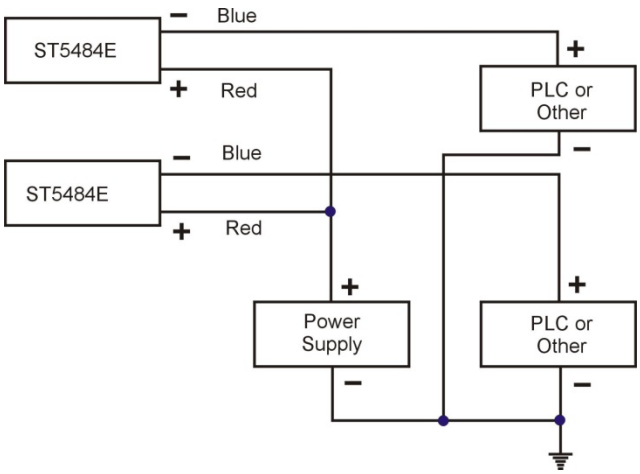


Figure 4: Typical installation for multiple ST5484E seismic vibration transmitters.

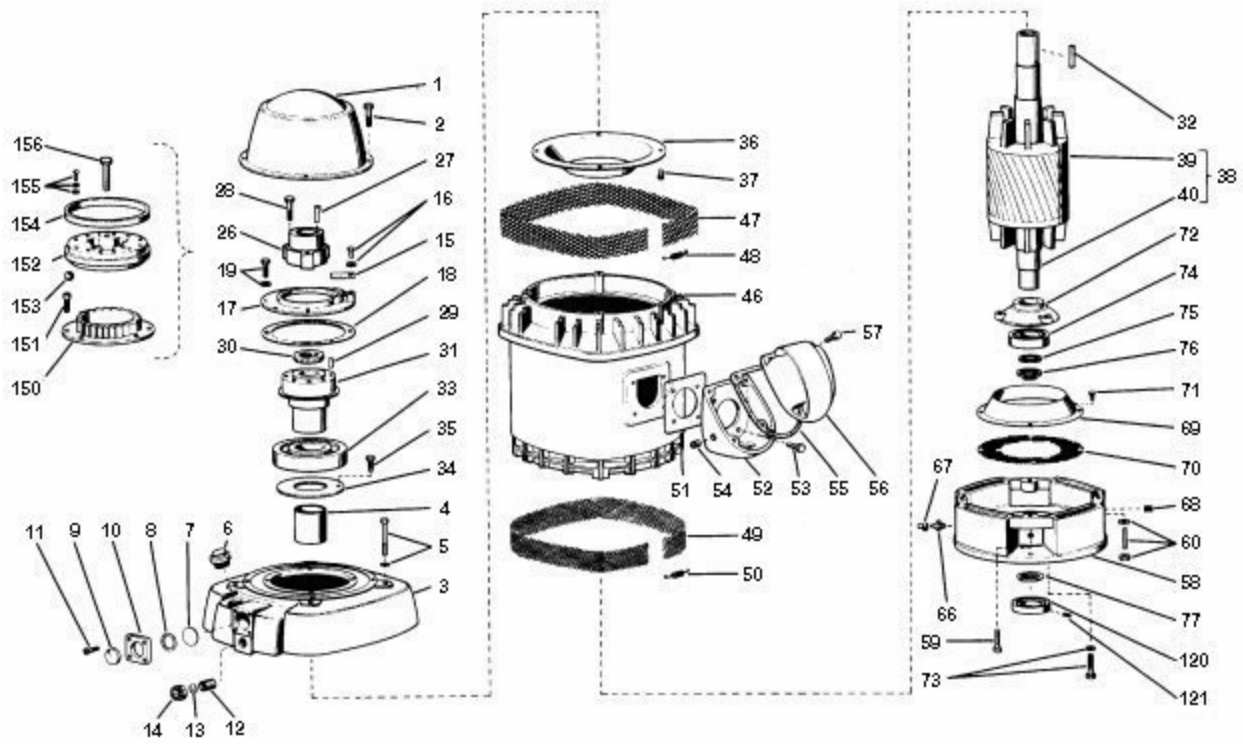
ADDITIONAL DOCUMENTATION

Description	Metrix Document Number
Manual	M9162
Installation Drawing – Hazardous Area with I.S. Barriers (CSA)	9426
Installation Drawing – Hazardous Area with I.S. Barriers (CENELEC)	9278
Installation Drawing – Div 2 / Zone 2	1086105

RENEWAL PARTS

FRAMES 324 THRU 447 - OPEN DRIPPROOF MOTORS
TYPES: RU, RUE, RUI, RUS, RUSI, RV, RV4, RVE, RVE4, RVI, RVI4, RVS, RVS4

HIGH THRUST - WEATHER PROTECTED TYPE 1 - P BASE
HOLLOSHAFT & SOLIDSHAFT MOTORS



ITEM NO.	QTY	NAME OF PART
1	1	Canopy Cap
2	3	Hex Head Cap Screws (Canopy Cap)
3	1	Upper Bracket Assembly
4	1	Oil Retaining Tube
5	4	Hex Head Cap Screw & Lockwasher (Bracket to Stator)
6	1	Special Plug
7	1	Reflector Disc
8	2	Gasket - Sight Gauge
9	1	Sight Gauge Window
10	1	Sight Gauge Housing
11	4	Oval Head Screw (Sight Gauge)
12	1	Nipple Fitting (Oil Drain)
13	1	Gasket or "O" Ring

ITEM NO.	QTY	NAME OF PART
14	1	Drain Cap
15	1	Locking Arm
16	1	Hex Head Cap Screw & Lockwasher
17	1	Dust Ring
18	1	Gasket (Dust Ring)
19	3	Hex Head Cap Screw & Lockwasher
20-25	-	NOT USED THIS ASSEMBLY
26	1	Coupling (RU & RUE only)
27	1	Gib Key
28	3	Hex Head Cap Screw & Lockwasher (Bearing Mounting)
29	3	Spring Pin
30	1	Locknut / Lockwasher

WARNING:
Any disassembly or repair work on explosionproof motors will void the Underwriters Laboratories, Inc.label unless done by the manufacturer, or a facility approved by the Underwriters Laboratories, Inc.Refer to your nearest sales office for assistance.

BEARINGS:
Refer to motor nameplate for the bearing numbers.

PRICES:
Parts stocking distributors: refer to renewal parts numerical index.All Others: refer to your nearest parts distributor.

reference: Renewal Parts Section 700, Pages 149 & 150

RENEWAL PARTS

FRAMES 324 THRU 447 - OPEN DRIPPROOF MOTORS
TYPES: RU, RUE, RUI, RUS, RUSI, RV, RV4, RVE, RVE4, RVI, RVI4, RVS, RVS4

HIGH THRUST - WEATHER PROTECTED TYPE 1 - P BASE
HOLLOSHAFT & SOLIDSHAFT MOTORS

ITEM NO.	QTY	NAME OF PART
31	1	Bearing Mounting
32	1	Square Key
33	1	Ball Bearing (Upper) (Refer to Section 775)
34	1	Metering Plate (Used on 444 & 445 frames only)
35	1	Hex Head Cap Screw & Lockwasher (Used on 444 & 445 frames only)
36	1	Air Deflector (Upper)
37	7	Self-Tapping Screw (Air Deflector) Use Qty. 8 on 404 & 405 frame & Qty. 6 on 444 & 445 frame
38	1	Rotor Assembly (Includes items 39 & 40)
39	1	Rotor Core
40	1	Rotor Shaft
41-45	-	NOT USED THIS ASSEMBLY
46	1	Wound Stator Assembly
47	1	Grill (Upper Fame)
48	1	Expansion Spring
49	1	Grill (Lower Frame)
50	1	Expansion Spring
51	1	Gasket (Outlet Box Base)
52	1	Outlet Box Base
53	4	Hex Head Cap Screw
54	1	Hex Head Countersunk Pipe Plug
55	1	Gasket (Outlet Box Cover)
56	1	Outlet Box Cover
57	4	Hex Head Cap Screw (Outlet Box Cover)
58	1	Lower Bracket "P" Base
59	4	Hex Head Cap Screw (Not used on 404 & 405 frames)
60	4	Stud / Nut & Washer (Used on 404 & 405 frames only)

ITEM NO.	QTY	NAME OF PART
61-65	-	NOT USED THIS ASSEMBLY
66	1	Grease Fitting
67	1	Plastic Cap (Used on frames 404, 405, 444 & 445 only)
68	1	Pipe Plug
69	1	Lower Air Deflector
70	1	Lower Screen
71	4	Hex Head Cap Screw & Lockwasher (Qty. 8 on 404 & 405 frames, Qty. 6 on 444 & 445 frames)
72	1	Lower Bearing Cap
73	3	Hex Head Cap Screw / Lockwasher
74	1	Ball Bearing (Lower) (Refer to Section 775)
75	1	Bearing Spacer (Lower)
76	1	Snap Ring
77	1	Water Deflector
FOR UNITS WITH STABILIZER BUSHINGS, OMIT ITEM NO. 77 & ADD THE FOLLOWING:		
120	1	Stabilizer Bushing
121	2	Socket Set Screws
FOR UNITS WITH NON-REVERESE RATCHETS, OMIT ITEM NO.'s 15, 17 & 19 AND ADD THE FOLLOWING:		
150	1	Stationary Ratchet
151	3	Socket Head Cap Screws
152	1	Rotating Ratchet
153	12	Steel Balls
154	1	Ball Retaining Ring
155	6	Round Head Machine Screws, Lockwasher & Plain Washers
156	3	Hex Head Cap Screws

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BEARINGS:
Refer to motor nameplate for the bearing numbers.

PRICES:
Parts stocking distributors: refer to renewal parts numerical index. All Others: refer to your nearest parts distributor.

reference: Renewal Parts Section 700, Pages 149 & 150

TYPICAL REED CRITICAL FREQUENCY DATA

Note: Motor RCF Test Data can be provided at time of motor shipment through special test. Please contact your Nidec Motor Corporation representative for more information.

MODEL NO: NA
CATALOG NO: NA

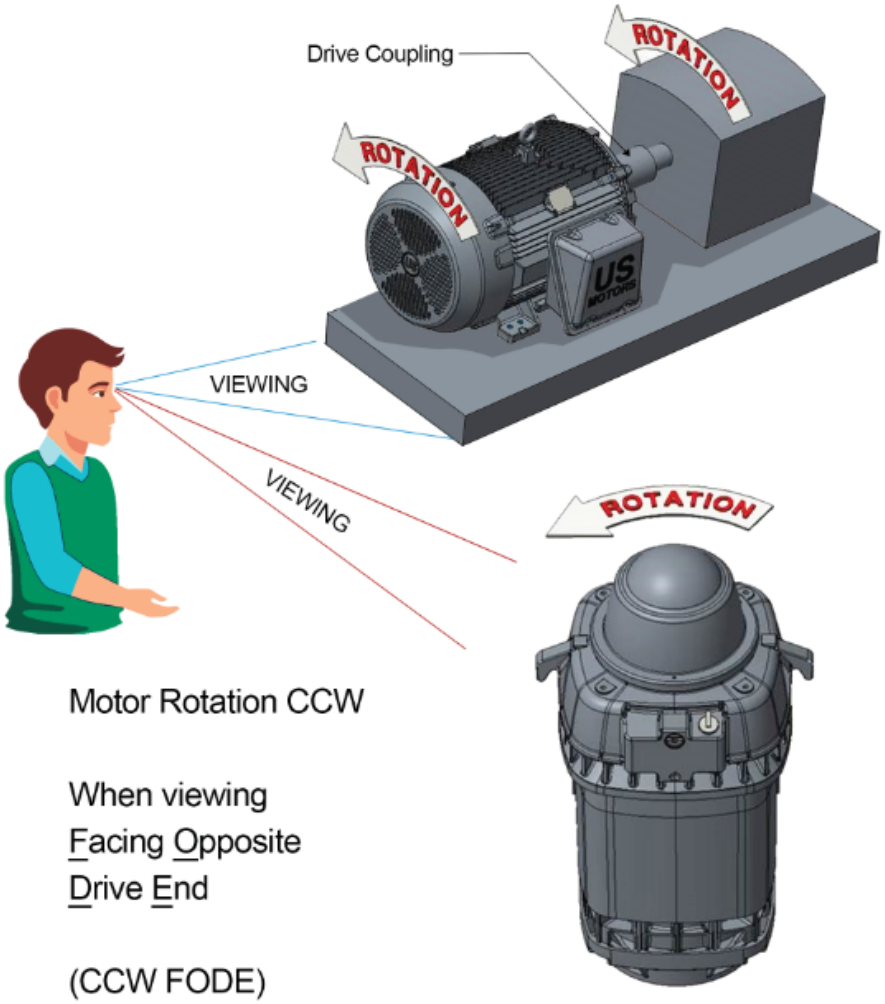
Frame: 447VP Type: RVS4

REED CRITICAL FREQUENCY:	29	HZ
CENTER OF GRAVITY:	22	IN
DEFLECTION @ CENTER OF GRAVITY:	0.012	IN
UNIT WEIGHT:	2100	LBS
BASE DIAMETER:	16.5	IN
TOLERANCE ON RCF VALUE:	10%	
DATE:	1/6/2021	

DIRECTION OF ROTATION

This motor is unidirectional and can only be operated in one direction to ensure proper cooling.

The motor will be supplied with the industry standard CCW (counter clockwise) rotation as shown below. CW rotation is available upon request.



Motor Rotation CCW

When viewing
Facing Opposite
Drive End

(CCW FODE)

NIDEC MOTOR CORPORATION
ST. LOUIS, MISSOURI

80-289