CITY OF BEAUMONT, TEXAS

CONTRACT DOCUMENTS
FOR CONSTRUCTION OF

COLLIER'S FERRY PUMP STATION

BEAUMONT
TEXAS

JANUARY 2022
ISSUED FOR BID

APPROVED BY:

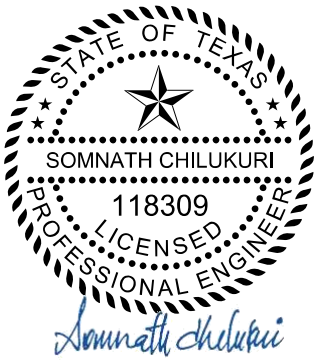
John Pippins III, EIT
Water Utilities Design Manager

Amalia Villarreal, P.E.
City Engineer

Bart Bartkowiak
Director of Public Works and Technology Services

FREESE AND NICHOLS
Texas Registered Engineering Firm F-2144
FNI Project No. BMT20326
City Bid No. WU0222-14

00 01 07 DESIGN PROFESSIONAL SEALS

	Specification Sections Sealed
 02-01-2022 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Divisions 00, 01, 02, 09, 10, and 44 Specifications 33 01 01, 33 01 02, 33 01 03, 33 05 01.02, 40 05 50, 40 05 53, 40 05 64, 40 05 65.29, 40 05 78, and 40 90 02.01

	Specification Sections Sealed
 01/07/2022 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Specifications 33 05 01.07, 33 13 54, 33 23 24, 33 30 00, 33 31 13.13, 33 39 13, 33 73 15, and 33 73 16

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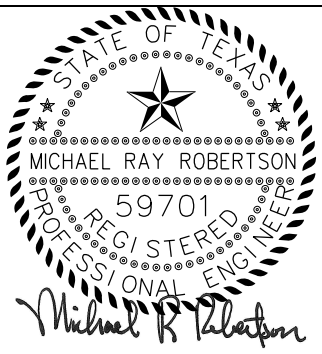 01/07/2022 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Division 03 and 05 Specifications 31 05 13, 31 05 16, 31 23 10, and 31 23 23.34

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 01/14/2022 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Division 23

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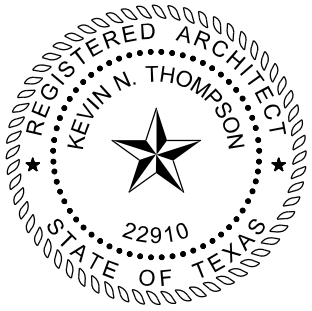 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Division 08

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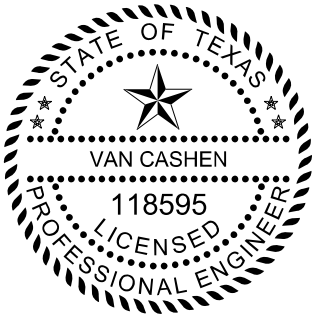 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Division 23

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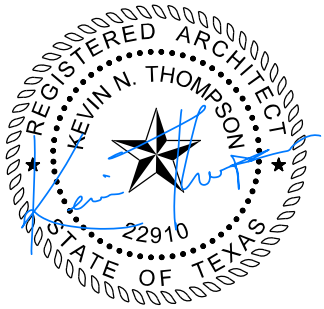 01/12/2022 FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	Division 08

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00 11 16 INVITATION TO BID

ARTICLE 1 – GENERAL NOTICE

1.01 The City of Beaumont (Owner) is requesting Bids for the construction of the following Project:

Collier's Ferry Pump Station
Bid No. WU0222-14.

1.02 Description of the Work

A. This project consists of flood protection improvements at the water treatment plant, including, but not limited to:

1. Structural modifications at Lawson Pump Station Forebay
2. Construction of Collier's Ferry Pump Station, including:
    a. Site Work - fill and grading, clearing and grubbing, fencing, gravel, and asphalt access road
    b. Structural - wet well, Electrical Building, concrete slabs, and concrete pipe supports
    c. Process Mechanical - four submersible pumps, associated piping, valves, and fittings, wet well hatches, sluice gates, NPW piping, yard piping, flow meter, and pipe supports
    d. Electrical - 1500kW generator, transfer switch, variable frequency drives, lightning protection, instrumentation, and lighting
    e. HVAC – four wall pack HVAC units at the Electrical Building
3. Microtunneling
    a. Approximately 2,500 linear feet of 48-inch diameter pipeline constructed by microtunneling extending between the Lawson Pump Station Forebay and the wet well of the Collier's Ferry Pump Station, in two separate drives. This includes construction of two manholes, one at the Lawson Pump Station site and one at approximately the midpoint of the pipeline alignment, and piping installed by traditional open cut methods as necessary.

1.03 The Project is to be substantially complete and ready for operation within 840 calendar days from Notice to Proceed. The Project is to be complete and eligible for final payment 60 days after the date for Substantial Completion.

ARTICLE 2 – EXAMINATION AND PURCHASE OF DOCUMENTS

2.01 Advertisement and bidding information for the Project can be found at the following procurement website or the City's website:

www.civcastusa.com

https://beaumonttexas.gov/departments/purchasing/bid-information/

2.02 Prospective Offerors must register with the procurement website as a plan holder, even if the Contract Documents are obtained from a plan room or other site. All official notifications, Addenda, and other documents will be offered only through the procurement website.

2.03 The Contract Documents may be downloaded from the procurement website by prospective Offerors registered as plan holders. Offerors are responsible for ensuring that a complete set of documents, as defined in Section 00 52 13 "Agreement," are used in the preparation of their Bids. The documents are made available for the sole purpose of obtaining Bids for completion of the Project 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 Offerors to print documents for their sole use, provided they pay all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.

2.04 The procurement website will be updated periodically with Addenda, lists of interested parties, reports, or other information relevant to submitting a Bid for the Project.

2.05 Printed copies of the Contract Documents, Technical Data, and other information may be examined free of charge at the following address:

City of Beaumont
1350 Langham Road
Beaumont, TX 77707
Hours Available for Viewing: 8 AM to 5 PM

ARTICLE 3 – PRE-BID CONFERENCE

3.01 A mandatory pre-bid conference for the Project will be held on February 17, 2022 at 1:30 PM. Interested parties may attend in person at the address below or via Microsoft Teams by internet or phone call at the link and phone number below.

City of Beaumont
801 Main Street
Beaumont, TX 77701

https://bit.ly/3ogmTkW
+1 903-405-2009
Passcode: 399 935 326#

ARTICLE 4 – SITE TOUR

4.01 A tour of the Site will be held the afternoon of the pre-bid conference. Prospective Offerors attending this site tour are required to arrange their own transportation to the Site. Maps to the Site will be available at the pre-bid conference.

ARTICLE 5 – QUESTIONS REGARDING BIDDING PROCESS OR SOLICITATION DOCUMENTS

5.01 Questions are to be submitted using the question and answer process on the procurement website. Responses to questions posted on the procurement website will be posted for the benefit of all Offerors. A response will be posted for questions submitted until 2:00 p.m. on March 10, 2022.

5.02 A response to a question posted on the procurement website that requires modification of the Contract Documents will be made by Addenda. Modifications to the Contract Documents prior to the award of the Contract can only be made by Addenda. Only answers in Addenda posted on the procurement website will be binding. Oral and other interpretations or clarifications will be without legal effect.

ARTICLE 6 – BID SECURITY

6.01 Offerors must submit an acceptable Bid Security with their Bids as a guarantee that the Successful Offeror will enter into a contract for the Project with the Owner within 15 days of Notice of Award of the Contract. The Bid Security must be payable to City of Beaumont in the amount of 5 percent of the proposed Contract Price. The Successful Offeror must execute the Contract and bonds on the forms provided in the Contract Documents and provide evidence of insurance as required by the Contract Documents.

6.02 Bid Security may be in the form of a bid bond, a cashier's check, or certified check. Checks must be made out to City of Beaumont. The bid bond may be submitted on the form provided in Section 00 43 13 "Bid Bond" or Offerors may provide their surety's standard penal sum bid bond form. The bid bond must reference the Owner and Project by name as identified in this Section.

ARTICLE 7 – DELIVERY OF BIDS

7.01 Sealed Bids must be delivered to the Owner at the address below no later than March 17, 2022 at 2:00 pm to be accepted. The Bids will be publicly opened and read aloud at this time and place including the names of the Offerors and their Bids. Bids received after this time will be returned unopened. Address Bids to the Owner as follows:

City of Beaumont
Tina Broussard, City Clerk
Attn: Bid – Collier's Ferry Pump Station [Bid No. WU0222-14]
801 Main Street, Suite 125
Beaumont, TX 77701

ARTICLE 8 – AWARD OF CONTRACT

8.01 It is the intent of the Owner to award this Contract to the lowest responsible Offeror. The Owner reserves the right to adopt the most advantageous interpretation of the Bids submitted

in the case of ambiguity or lack of clearness in stating bid prices, to reject any or all Bids, and/or waive formalities. Bids will remain subject to acceptance and may not be withdrawn within 90 days from the date on which Bids are opened.

ARTICLE 9 – OTHER CONTRACT REQUIREMENTS

9.01 Selected Contractor will be required to pay the prevailing wage rates established for this Project in accordance with the Contract Documents and Tex. Gov't Code Chapter 2258.

9.02 Performance, payment, and maintenance bonds will be required for this Project.

END OF SECTION

00 21 13 INSTRUCTIONS TO OFFERORS

ARTICLE 1 – DEFINED TERMS

1.01 The terms used in these Instructions to Offerors have the meanings assigned to them in the General Conditions and Supplementary Conditions.

ARTICLE 2 – RECEIPT OF BIDS

2.01 Refer to Section 00 11 16 “Invitation to Bid” for information on receipt of Bids.

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. Offeror 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 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. Examine the Contract Documents and supplemental data:

1. Carefully study the Contract Documents.
2. Carefully study supplemental information, including Technical Data, record drawings from previous projects, available utility maps, reports, and studies referenced or made available to the Offeror.
3. Promptly notify the Construction Manager of all conflicts, errors, ambiguities, or discrepancies that the Offeror discovers in the Contract Documents, Addenda, and supplemental information.
4. Determine that the Contract Documents, Addenda, and supplemental data are generally sufficient 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.
5. 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.

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

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. A tour of the Site will be conducted at the pre-bid conference.

D. Subsurface exploration using a backhoe, drilling rig, or other equipment can be done, providing the following procedures are followed:

1. Contact the following individual to coordinate the details for the subsurface exploration:

   Troy Pierce – Plant Manager
   City of Beaumont
   Troy.Pierce@BeaumontTexas.gov

2. Backfill excavation with material acceptable to the Owner and process backfill to prevent future settling.

3. Pay all costs for soils investigation including the cost for excavation, backfill, access, and testing.

E. The submission of a Bid will constitute an incontrovertible representation by the Offeror that the Offeror has complied with every requirement of this Article, and that without exception the Bid is premised on the following:

1. Work will be completed in accordance with the Contract Documents for the Contract Price within the Contract Times;

2. Offeror has given the Construction Manager written notice of all conflicts, errors, ambiguities, and discrepancies that the Offeror has discovered in the Contract Documents, Addenda, and the related supplemental data;

3. Written resolutions provided by the Construction Manager are acceptable to the Offeror; and

4. Contract Documents, Addenda, and the related supplemental data are generally sufficient to indicate and convey understanding of all terms and conditions for completion of Work.

ARTICLE 6 – PRE-BID CONFERENCE

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

ARTICLE 7 – INTERPRETATIONS AND ALTERNATE BIDS

7.01 Submit all questions about the meaning or intent of the Contract Documents, Addenda, and the related supplemental data to the Construction Manager using the procurement website as indicated in Section 00 11 16 “Invitation to Bid.”

7.02 Submit any offer of alternate terms and conditions or offer of Work not in strict compliance with the Contract Documents to the Construction Manager no later than 10 days after the date Project is initially advertised. Construction Manager and Design Professional will issue Addenda as appropriate if any of the proposed changes to the Contract Documents are accepted. A Bid

submitted with clarifications or taking exceptions to the Contract Documents, except as modified by Addenda, will be considered non-responsive.

7.03 Offeror may submit a separate and additional Bid if the Offeror includes exceptions or the Offeror wishes to make a Bid that is not in accordance with the terms and conditions of the Contract Documents, or for Work that is not in strict compliance with the Contract Documents. Describe the intent and substance of the changes in the additional Bid in adequate detail so they are clearly understood. Alternate Bids will not be considered in the evaluation of the Bids. Upon selection of the Bid of the lowest responsible Offeror, and after the award of the Contract, the Construction Manager may issue a Request for a Change Proposal if Owner chooses to accept any Bid alternates.

7.04 Addenda may be issued to clarify, correct, or change the Contract Documents, Addenda, or the related supplemental data as deemed advisable by the Owner or Designer.

ARTICLE 8 – BID SECURITY

8.01 Offerors must submit an acceptable bid bond, cashier's check, or certified check as Bid Security with their Bids as required by Section 00 11 16 "Invitation to Bid." The acceptable bid bond must be issued by a surety legally authorized to do business in Texas and meet the requirements of the General Conditions. Cashier's or certified checks must be made payable to the City of Beaumont and are to be effective on the day Bids are submitted and valid for a period of at least 90 days from the date the check is issued.

8.02 Owner may annul the Notice of Award and retain the Bid Security of the apparent Successful Offeror upon Offeror's failure to execute and deliver the Agreement or Amendments to the Agreement.

8.03 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. Cashier's or certified checks will be returned by the Owner when the Contract is executed, or all Bids are rejected.

ARTICLE 9 – CONTRACT TIMES

9.01 See applicable provisions for Contract Times in the Agreement.

ARTICLE 10 – LIQUIDATED DAMAGES, RETAINAGE, AND INTEREST

10.01 Provisions for liquidated damages and the payment of retainage and interest are set forth in the Agreement.

ARTICLE 11 – PREPARATION OF THE BID FORM

11.01 The Bid Form is included with the Contract Documents and is also available at the procurement website. 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 Execute the Bid Form as indicated in the document and include evidence of authority to sign.

11.03 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.

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

11.05 Provide evidence of the Offeror'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 Offeror will forfeit its Bid Security.

ARTICLE 12 – CONFIDENTIALITY OF BID INFORMATION

12.01 The Owner is a governmental body subject to the limitation of Tex. Gov't Code Chapter 552 and has limited obligations with regard to protecting confidential information submitted by Offerors. Bids will be opened in a manner that avoids disclosure of trade secrets and confidential information to competing Offerors and keeps the Bids from the public until a contract is awarded. The Owner will protect trade secrets and confidential information to the extent allowed by Laws and Regulations.

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 The Owner, upon receiving an application or other request for the disclosure of confidential information, will promptly notify Offeror of the request as required by Section 552.305 and request a ruling by the Texas Attorney General as to whether any such information may be released.

12.04 Offeror 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 Section 552.305(b) and that if disclosure is required, the Owner has no liability for releasing this information and Offeror will not be entitled to exercise any remedy for a disclosure made pursuant to the 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 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 Offeror with prompt notice of this request so that it may seek an appropriate protective order or other appropriate remedy.

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 Submit the Bid no later than the date and time prescribed and at the place indicated in Section 00 11 16 "Invitation to Bid." Enclose the Bid in an opaque sealed envelope plainly marked with the Project name and the name and address of the Offeror, along with the Bid Security and other required documents. Enclosed the sealed envelope containing the Bid in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED" if the Bid is sent by mail or other delivery system. Address the outer envelope to the mailing address shown in Section 00 11 16 "Invitation to Bid." Offeror 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 An Offeror may withdraw its Bid within 24 hours after Bids are opened if the Offeror 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 Security will be returned if it is clearly demonstrated to the Owner that there was a material and substantial mistake in its Bid. An Offeror 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 Offerors and the amount bid as required by applicable Laws and Regulations.

ARTICLE 16 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

16.01 All Bids will remain subject to acceptance for the number of days specified in Section 00 11 16 "Invitation to Bid." The Owner may, at its sole discretion, release any Bid and return the Bid Security prior to the end of this period.

ARTICLE 17 – EVALUATION OF BIDS

17.01 The Owner will consider the proposed Contract Price and Contract Times and the qualifications of the Offerors to determine the lowest responsible Offeror.

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 Offeror 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.

17.04 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 18 – AWARD OF CONTRACT

18.01 Owner reserves the right to reject any and all Bids, including non-conforming, non-responsive, or conditional Bids. The Owner may also reject the Bid of any Offeror if the Owner believes that it would not be in the best interest of the Owner to make an award to that Offeror. The 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, except as additional Bids in accordance with Article 7. Reasonable grounds for believing that any Offeror has an interest in more than one Bid for the Work will be cause for disqualification of that Offeror and the rejection of all Bids in which that Offeror has an interest.

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

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

A. Offeror'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 Offeror delivers the executed Agreement to the Owner, it must be accompanied by the performance and payment bonds and required evidence of insurance.

19.02 Provide performance and payment bonds for this Project that fully comply with the provisions of Tex. Gov’t Code Chapter 2253. Administration of these bonds will conform to Chapter 2253 and the provisions of the Contract Documents.

ARTICLE 20 – SIGNING OF THE AGREEMENT

20.01 The Notice of Award to the Successful Offeror 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 Offeror must sign and deliver the required number of counterparts of the Agreement and attached documents to the Owner within 15 days. The Owner will deliver two fully signed counterparts to the Successful Offeror within 10 days after receiving the signed documents from the Successful Offeror.

20.02 The Successful Offeror must also complete and submit a Certificate of Interested Parties (Form 1295) to the Owner as required by Tex. Gov't 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 local or state sales or use taxes, however certain items such as rented equipment may be taxable even though Owner is a tax-exempt agency. Offerors assume responsibility for including any applicable sales taxes in their Bids and 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 qualifies as a "separated contract." In order 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 "State Sales Tax Requirements." Bids that do not include the information requested in this Section may be considered non-responsive.

ARTICLE 22 – WAGE RATES

22.01 This Contract is subject to Tex. Gov't 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." Offerors will be required to pay at least the minimum wages shown on this list and comply with all applicable federal, state, and local Laws and Regulations related to the payment of prevailing wage rates.

ARTICLE 23 – PROHIBITED CONTRACTS

23.01 Owner may not enter into contracts with companies that are engaged in business with Iran, Sudan, or a company known to have contracts with or provide suppliers or services to a foreign terrorist organization in accordance with Tex. Gov't Code Chapter 2252 or a company boycotting Israel in accordance with Tex. Gov't Code Chapter 2270.

COLLIER'S FERRY PUMP STATION PROJECT
BID NO. WU0222-14

Texas Ethics Commission Certificate

HB 1295 -- Section 2252.098 of the Government Code states "a contract that requires an action or vote by the governing body of the entity or agency, or the value of the contract is at least one million dollars ($1,000,000), must provide a Disclosure of Interested Parties Form on the Texas Ethics Commission website".

Within fourteen (14) working days after the award of contract by Beaumont City Council, the awarded vendor must complete the information requested on the Texas Ethics Commission website and provide the certificate number to the Purchasing Department. The Texas Ethics Commission website is: www.ethics.state.tx.us

At the home page, click on Form 1295 Filing Application, and follow the instructions. **Upon completion of the information on the website, provide the completed form and certificate number to the following Purchasing e-mail addresses:**

terry.welch@beaumonttexas.gov
John.pippins@beaumonttexas.gov
Dara.woodruff@beaumonttexas.gov

I understand the requirement as stated above and will comply within fourteen (14) working days after the award of contract by Beaumont City Council.

_____	_____
Signature	Company Name
_____	_____
Printed Name	Date Signed
_____	
Title	

[THIS FORM MUST BE RETURNED WITH YOUR BID]

Revised 4/29/16 /bd

CITY OF BEAUMONT
COLLIER'S FERRY PUMP STATION PROJECT
BID NO. WU0222-14

House Bill 89 (HB89) Verification Form

I, _____, the undersigned representative of

_____, (Company or Business Name)

(hereafter referred to as "Company"), **being an adult over the age of eighteen (18) years of age, verify that the company named-above, under the provisions of Subtitle F, Title 10, Government Code Chapter 2270:**

1. **Does not boycott Israel currently; and**
2. **Will not boycott Israel during the term of the contract the above-named Company, business or individual with the City of Beaumont, Texas.**

Pursuant to Section 2270.001, Texas Government Code:

1. "Boycott Israel" means refusing to deal with, terminating business activities with, or otherwise taking any action that *is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes; and*
2. "Company" means *a for-profit sole proprietorship, organization, association, corporation, partnership, joint venture, limited partnership, limited liability partnership, or any limited liability company, including a wholly- owned subsidiary, majority-owned subsidiary, parent company or affiliate of those entities or business associations that exist to make a profit.*

_____ _____
DATE SIGNATURE OF COMPANY

REPRESENTATIVE ON THIS THE _____ day of _____, 20_____, personally appeared

_____, the above-named person, who after by me being duly sworn, did swear and confirm that the above is true and correct.

_____
NOTARY SEAL NOTARY SIGNATURE

Senate Bill 252 Ch. 2252 Certification

Pursuant to Texas Government Code, Chapter 2252, Section 2252.152 and Section 2252.153, certify that the company named above is not listed on the website of the Comptroller of the State of Texas concerning the listing of companies that are identified under Section 806.051, Section 807.051 or Section 2252.153. I further certify that should the above-named company enter into a contract that is on said listing of companies on the website to the Comptroller of the State of Texas which do business with Iran, Sudan or any foreign terrorist organization, I will immediately notify the City of Beaumont's Purchasing Department.

_____ _____
Date Signed Signature of Company Representative

_____
Name in Printed Form

[THIS FORM MUST BE RETURNED WITH YOUR BID]

END OF SECTION

00 21 14 REQUIRED FORMS CHECKLIST

ARTICLE 1 – REQUIRED FORMS CHECKLIST

1.01 The following is a list of forms that shall be completed and submitted with bid:

	TITLE	INITIALS
1.	Section 00 21 14 Required Forms Checklist	_____
2.	Texas Ethics Commission Certificate (end of Section 00 21 13 Instructions to Offerors)	_____
3.	House Bill 89 (HB89) Verification Form (end of Section 00 21 13 Instructions to Offerors)	_____
4.	Section 00 41 13 Bid Form	_____
5.	Section 00 41 16 Bid Form Exhibit A	_____
6.	Section 00 43 13 Bid Bond	_____
7.	Section 00 45 02 Non-Collusion Certification	_____
8.	Section 00 45 03 Conflict of Interest Questionnaire	_____
9.	Section 00 45 04 State Sales Tax Requirements	_____
10.	Section 00 45 13 Qualifications Statement	_____
11.	Section 00 73 16.1 Insurance Requirement Affidavit	_____
12.	Section 00 73 17 Texas Workers' Compensation Insurance	_____
13.	Section 00 73 47 Statement of City Charter	_____
14.	Section 00 73 48 Corporate Resolution	_____
15.	Section 00 73 50 Minority Business Participation Schedule	_____
16.	Section 00 73 51 Certificate of Interested Parties Information	_____

Each form listed must be completed and submitted with the bid. The person preparing the bid is to initial next to each form listed in the blank space provided to confirm that the corresponding form was filled out and submitted as part of the bid package. **DO NOT STAPLE BID DOCUMENTS BEING SUBMITTED.**

I, _____, verify that all required forms were submitted with the bid package.

_____ _____

Signature **Date**

NOTE: OMISSION OF ANY OF THE ABOVE FORMS MAY RESULT IN THE CITY REJECTING BID.

END OF SECTION

00 41 13 BID FORM

ARTICLE 1 – BID RECIPIENT

1.01 Offeror submits this Bid to:

The City of Beaumont
City Hall, City Clerk's Office
801 Main Street, Suite 125
Beaumont, TX 77701
Attention: City Clerk
Collier's Ferry Pump Station
Bid No. WU0222-14

ARTICLE 2 – OFFEROR'S ACKNOWLEDGMENTS

2.01 Offeror 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. Offeror 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 Offeror accepts all of the terms and conditions of Section 00 11 16 "Invitation to Bid" and Section 00 21 13 "Instructions to Offerors."

2.03 Offeror 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 Offeror acknowledges receipt of the following Addenda:

Addendum No.	Addendum Date	Signature Acknowledging Receipt

ARTICLE 3 – OFFEROR'S REPRESENTATIONS

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

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

3.04 Offeror 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 Offeror has considered the:

A. Information known to the Offeror;

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 Offeror has considered the items identified in this Article 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 Offeror; and

C. Offeror's safety precautions and programs.

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

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

3.12 Offeror'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.

ARTICLE 4 – BASIS OF OFFER

4.01 Offeror will complete the Work in accordance with the Contract Documents for:

Lump Sum Bid Price	$

ARTICLE 5 – TIME OF COMPLETION

5.01 Offeror 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 6 – ATTACHMENTS TO THIS BID

6.01 All documents listed in Section 00 21 14 Required Forms Checklist are to be attached to and made a condition of this Bid.

ARTICLE 7 – VENUE

7.01 Offeror agrees that venue will lie exclusively in Jefferson County, Texas for any legal action.

ARTICLE 8 – BID DELIVERY

8.01 This Bid is offered by:

Offeror: _____
(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 Offeror is a corporation, partnership, or a joint venture.)

END OF SECTION

00 41 16 Bid Form Exhibit A

Project:	Collier's Ferry Pump Station		**Project No.:**
Owner:	City of Beaumont		BMT20326
Design Professional:	Freese and Nichols, Inc.		Bid No. WU0222-14
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	Mobilization	LS	1		
A-02	Stormwater Pollution Prevention	LS	1		
A-03	**Site Work** Including but not limited to fill and grading, clearing and grubbing, fencing, gravel, and asphalt access road.	LS	1		
A-04	**Structural Work** Including but not limited to modifications at Lawson Pump Station, Colliers RWPS wet well, Electrical Building, concrete slabs, and concrete pipe supports.	LS	1		
A-05	**Process Mechanical Work** Including but not limited to four submersible pumps, associated piping, valves, and fittings, wet well hatches, sluice gates, NPW piping, yard piping, flow meter, and pipe supports.	LS	1		
A-06	**Electrical, Instrumentation and Controls**	LS	1		
A-07	**Tunneling** Including but not limited to 48-inch microtunnel, two launch shafts and one intermediate shaft, and manholes.	LS	1		
A-08	**HVAC** Including but not limited to four wall pack HVAC units at the Electrical Building.	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)**				$ -
Extra Work Items in Base Bid per Section 01 23 10 "Alternates and Allowances"					
D-01	**Additional Flexbase Paving** Bid for additional flexbase paving not shown on the Drawings. Flexbase Paving shall be installed at locations designated by the Owner.	SY	500		
D-02	**Additional Structural Excavation** Bid for additional "unclassified" structural excavation not shown on the Drawings or required by the specifications and as directed by the Owner.	CY	1,000		
D-03	**Additional Structural Backfill** Bid for additional compacted structural select backfill not shown on the Drawings or required by the specifications and as directed by the Owner.	CY	1,000		
D-04	Additional Concrete	CY	100		
D-05	Additional Concrete Grout in Place	CY	100		
D-06	Additional Rebar	LF	100		
D-07	**Bid Allowance No. 1** Unsuitable soils removal, disposal off-site, and replacement	LS	1	$ 25,000.00	
D	**Total Extra Work Amount**				$ -
E	**Total Base Bid with Extra Work Allowances (Sum of C and D)**				$ -

Item No.	Item Description	Unit	Estimated Quantity	Unit Price	Extended Amount

Contract Time

F	Offeror agrees to reach Substantial Completion in	840	days
G	Offeror agrees to reach Final Completion in	900	days

Cost + Time Evaluation

H	Total Base Bid (Line E)	$	-
I	Offeror Days to Substantial Completion		days
J	Value per Day of Construction	$ -	per day
K	Value for Days of Construction (I X J)		
L	Basis for Comparison of Bids (H + K)		

Notes	
1	Provision is made for Offeror 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 bid items as applicable.

BID SUBMITTED BY:

Offeror: _____

Signature: _____

Printed Name: _____

Title: _____

Date: _____

00 43 13 BID BOND

Offeror as Principal Name: Mailing address (principal place of business):	**Surety** Name: Mailing address (principal place of business):
Owner Name: Mailing address (principal place of business):	Physical address (principal place of business): Telephone (Main): Telephone (Claims): Surety's state of incorporation:
Contract Project name and number: Bid/Proposal Due Date:	***By submitting this bond, Surety affirms it is authorized to do business and licensed to execute bonds in Texas.***
Bond Contract Price Offered: Penal Sum of Bond: 5% of Contract Price offered Date of Bond:	**Local Agent for Surety** Name: Company: Mailing address (principal place of business): Telephone (Main):

Surety and Offeror, 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 Offeror 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 Offeror's Bid or Proposal and Offeror delivers the executed Agreement and the required bonds and evidence of insurance within the time stipulated in the Bidding or Proposal Documents this obligation is null and void. Payment under this bond will be due and payable upon default by Offeror and within 30 calendar days after receipt by Offeror and Surety of written notice of default from Owner. Venue lies exclusively in Jefferson County, Texas for any legal action.

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

END OF SECTION

00 45 02 NON-COLLUSION CERTIFICATION

By submission of this proposal, the Offeror _____

certifies that (s)he is _____ of _____

under penalty of perjury, affirms:

1. The prices in this proposal have been arrived at independently without collusion, consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other Offeror or with any competitor;

2. Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the Offeror and will not knowingly be disclosed by the Offeror prior to opening, directly or indirectly, to any other Offeror or to any competitor; and

3. No attempt has been made or will be made by the Offeror to induce any other person, partnership or corporation to submit or not submit a proposal for the purpose of restricting competition.

4. The proposal was not made in the interest of or on behalf of any undisclosed person, partnership, company, organization or corporation.

5. Each person signing the proposal certifies that:

    a. He is the person in the Consultant's organization responsible within that organization for the decision as to prices being offered in the proposal and that he has not participated and will not participate in any action contrary to (1-4] above; or

    b. He is not the person in the Consultant's organization responsible within that organization for the decision as to prices being offered in the proposal but that he has been authorized in writing to act as agent for the persons responsible for such decisions in certifying that such persons have not participated, and will not participate, in any action contrary to (1-4) above, and that as their agent, does hereby so certify; and that he has not participated, and will not participate in any action contrary to (1- 4) above.

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 STATE SALES TAX REQUIREMENTS

Comply with all applicable sales, excise, and use tax requirements of the Texas Tax Code. The Offeror 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) $ _____

Offeror: _____
(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 Offeror 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 13 QUALIFICATIONS STATEMENT

ARTICLE 1 – REQUIREMENTS FOR THE QUALIFICATIONS STATEMENT

1.01 The Qualifications Statement must be submitted 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. Offerors 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 Offerors must provide the information requested in this Qualifications Statement using the forms attached to this Section. These forms are available in Microsoft Word or Excel on the procurement website. 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 Offerors 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 Offeror’s Organization and General Information:

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

B. Provide information regarding the operational structure of the Offeror’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 the Project is located in. If the Project is located in a state that licenses contractors, Offeror must also provide documentation showing that the organization is licensed as a general contractor in that state, including any applicable classifications and limitations.

C. Financial Management:

1. Provide Offeror’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 Offeror's financial summary information in Table 1, including the financial indicators from the Offeror'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 Offeror to provide adequate cash flow for the Project if Offeror's Current Ratio or Quick Ratio are less than 1.0.

D. Safety:

1. Provide a narrative not to exceed four pages describing the Offeror's success in implementing an effective project site safety program. Provide a narrative describing the Offeror's safety program and a statement regarding the organization's commitment to safety. Offerors 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 Offeror 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 Offeror'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 Offeror'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 Offeror 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 Offeror on this Project.

2.02 Project Experience:

A. Provide a list of up to 10 projects completed by the Offeror in the last 5 years using copies of Table 2.

B. Provide detailed descriptions of projects which demonstrate the experience of the Offeror'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 10 years. Offerors not

meeting the requirement for similar projects may be disqualified as being non-responsive. Similar projects include:

1. Chemical system improvements, plant electrical improvements, and plant civil work.

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 Offeror.

2.03 Experience and Qualifications of Proposed Key Personnel:

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

B. Provide information on the key personnel proposed for this Project on Tables 3 through 7. Key personnel include the project manager, project superintendent, safety manager, quality control manager, microtunnel contractor, microtunnel project manager, microtunnel superintendent, and microtunnel operator. The Offeror may provide information on an alternate individual if the Offeror 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 Offeror. The Offeror 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 Offeror 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 the qualifications to fulfill each role if an individual is to fulfill more than one of the key personnel roles.

F. Provide a tabulation of the projects on which the key personnel have been personally involved using copies of Table 7. This tabulation is to include the name and a current telephone number for references for each of these project assignments.

G. 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.

H. Provide a narrative not to exceed ten pages to describe the overall performance of the individuals on these projects. This narrative may include references to letters of recommendation, project awards, and other references to demonstrate experience in constructing a project which meets the owner's expectations for a quality project constructed on time and within budget.

2.04 Offeror's Ability to Complete Projects within the Contract Price and Contract Times:

A. Provide a tabulation of budget performance on projects completed by the Offeror within the last 5 years using copies of Table 8 to demonstrate the ability of the Offeror to complete projects for the Contract Price. Notes may be added to each line item to describe circumstances for change orders beyond the control of the Offeror.

B. Provide a tabulation of all projects completed by the Offeror within the last 5 years on Table 9 to demonstrate performance in completing projects on time. Notes may be added to the tabulations to indicate the reasons for not meeting original contract completion dates.

ARTICLE 3 – BID 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 Bid. Each appendix must reference the section of the criteria if is in reference to.

3.03 Provide one printed copy of the Bid at the time and place set forth in Section 00 11 16 "Invitation to Bid." Provide a digital copy of the Bid in Portable Document Format (pdf) on a CD. This digital copy is to include all information required to evaluate the Bid.

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 10 Years
3	Proposed Project Managers
4	Proposed Project Superintendents
5	Proposed Project Safety Managers
6	Proposed Project Quality Control Managers
7	Project Information for Key Personnel

Table	Description
8	Demonstration of Budget Performance
9	Demonstration of On-Time Performance

ARTICLE 5 – CERTIFICATION

5.01 By submitting this Qualifications Statement and related information, Offeror certifies that it has read this Qualifications Statement and that Offeror'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 Offeror's organization.

Offeror: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed

Attest: _____
(individual's signature)

Designated Representative:

Name: _____

Title: _____

Address for giving notices:

_____

_____

_____

Phone: _____ Email: _____

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

Table 1 - General Information

Organization			
Legal Name of Business			
Form of Business Entity: ☐ 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 organization or a participating or predecessor organization ever been disqualified as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes* ☐ No			
Has this organization or a participating or predecessor organization ever been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes* ☐ No			
Has this organization or a participating or predecessor organization been released from a bid or proposal in the past 5 years? ☐ Yes* ☐ No			
Has this organization or a participating or predecessor organization ever defaulted on a project or failed to complete any contract awarded to it? ☐ Yes* ☐ No			
Has this organization or a participating or predecessor organization ever refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes* ☐ No			
Is this organization or a participating or predecessor organization currently involved in any litigation or contemplating litigation? ☐ Yes* ☐ No			
Provide full details in a separate attachment for each statement above with a "yes" response above.			
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 number)			
Telephone (for notice of claims)			
Local Agent for Provider			
Address for Local Agent			
Telephone for Local Agent			

Construction Site Safety Experience

Provide Offeror'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 that will provide Work valued at 25% or more of the Contract Price.

Year	Offeror		Subcontractor		Subcontractor		Subcontractor	
	EMR	TRFR	EMR	TRFR	EMR	TRFR	EMR	TRFR
1								
2								
3								

Table 1 - General Information Cont'd

Financial Summary Information for Offeror	
Date of Offeror's most current financial statement	
Date of Offeror's most current audited financial statement	
Financial indicators from the most current financial statement:	
Offeror's Current Ratio = Current Assets ÷ Current Liabilities	
Offeror's Quick Ratio = (Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities	
Describe the resources that are available to the Offeror to provide adequate cash flow for the Project if Offeror'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 10 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	
Role on project		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	
Role on project		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	
Role on project		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	
Role on project		Role on project	

Table 5 - Proposed Project Safety Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project safety manager			
Years of experience with this organization			
Number of similar projects as project safety 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	
Role on project		Role on project	
Alternate Candidate			
Name of individual			
Years of experience as project safety manager			
Years of experience with this organization			
Number of similar projects as project safety 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	
Role on project		Role on project	

Table 6 - Proposed Project Quality Control Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as quality control manager			
Years of experience with this organization			
Number of similar projects as quality control 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	
Role on project		Role on project	
Alternate Candidate			
Name of individual			
Years of experience as quality control manager			
Years of experience with this organization			
Number of similar projects as quality control 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	
Role on project		Role on project	

Table 7 - Project Information for Key Personnel

Name of Organization					
Provide information on all projects completed by the Organization within the last 5 years.					
Project Owner		Project Name			
General Description of Project					
Project Budget and Schedule Performance					
Budget History	Amount	% of Bid Amount	Schedule Performance	Date	Days
Original Contract Price			Notice to Proceed		
Change Orders			Contract Substantial Completion Date at Notice to Proceed		
Owner Enhancements			Contract Final Completion Date at Notice to Proceed		
Unforeseen Conditions			Change Order Authorized Substantial Completion Date		
Design Issues			Change Order Authorized Final Completion Date		
Total			Actual / Estimated Substantial Completion Date		
Final Cost			Actual / Estimated Final Completion Date		

Key Project Personnel				
	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager
Name				
Percentage of time devoted to the project				
Percentage of time proposed for this Project				
Did Individual start and complete the project?				
If not, who started or completed the project in their place?				
Reason for change?				

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					
Surety					

Issues / disputes resolved or pending resolution by arbitration, litigation or dispute review boards							
Number of issues resolved		Total amount involved in resolved issues		Number of issues pending		Total amount involved in issues pending	

Table 8 - Demonstration of Budget Performance

Name of Offeror							
Provide information on all projects completed by the Offeror within the last 5 years.							
Owner Name	Project Description	Original Contract Price	Value of Change Orders			Total Change Orders	Percent of Changes to Original Contract Price
			Owner Enhancements	Unforeseen Conditions	Design Issues		
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							

Table 9 - Demonstration of On-Time Performance

Name of Organization							
Provide information on all projects completed by the Organization within the last 5 years.							
Owner Name	Project Description	Original Contract Date for Substantial Completion	Original Contract Date for Final Completion	Amended Contract Date for Substantial Completion	Amended Contract Date for Final Completion	Actual Contract Date for Substantial Completion	Actual Contract Date for Final Completion
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							

END OF SECTION

00 52 13 AGREEMENT

This Agreement is between the City of Beaumont (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:

Collier's Ferry Pump Station
Bid No. WU0222-14

ARTICLE 2 – DESIGN PROFESSIONAL

2.01 The Design Professional for this Project is:

Freese and Nichols, Inc.
Somnath Chilukuri, P.E.
11200 Broadway St., Ste. 2320
Pearland, TX 77584

ARTICLE 3 – CONSTRUCTION MANAGER

3.01 The Construction Manager for this Project is:

Freese and Nichols, Inc.
11200 Broadway St., Ste. 2320
Pearland, TX 77584

ARTICLE 4 – CONTRACT TIMES

4.01 Contract Times

A. The Work is required to be substantially complete within 840 calendar days after the date when the Contract Times commence to run as provided in the General Conditions and complete and ready for final payment in accordance with the General Conditions within 60 days after the date of Substantial Completion.

B. Milestones, the dates for completion of each, and associated liquidated damages are as defined in Section 01 35 00 "Special Procedures."

C. 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, 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):

1. Contractor agrees to pay Owner $2600 for each day that expires after the time specified in this Agreement for Substantial Completion until the Work is substantially complete.
2. Contractor agrees to pay Owner $2600 for each day that expires after the time specified in this Agreement for Final Completion until the Work is completed and ready for final payment in accordance with the General Conditions.

B. Liquidated damages for failing to timely attain Substantial Completion and Final Completion are not additive and will not be imposed concurrently.

C. 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.

D. Owner 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 failure to complete work within the specified Milestones described in Section 01 35 00 "Special Procedures." 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 complete work within the specified Milestone Dates.

ARTICLE 5 – CONTRACT PRICE

5.01 Owner will pay the Contractor the following amount for completion of the Work in accordance with the Contract Documents:

A	Lump Sum Base Bid Amount	$

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."

6.02 Owner will make progress payments on or about the 1st day of each month during performance of the Work. 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.

6.03 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.

6.04 Retainage

A. 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.

6.05 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.

6.06 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 No interest payments will be paid to the Contractor for invoices not paid when due as provided in the General Conditions.

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

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

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

D. 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.

E. Contractor has considered the:

1. Information known to Contractor;
2. Information commonly known to contractors doing business in the locality of the Site;
3. Information and observations obtained from visits to the Site; and
4. The Contract Documents.

F. 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.

G. 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.

H. 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.

I. Contractor has correlated the information known to the Contractor, 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.

J. 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.

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

L. 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.

ARTICLE 9 – ACCOUNTING RECORDS

9.01 Accounting Record Availability: Contractor is to establish and maintain, in accordance with generally accepted accounting practices, full and detailed accounting records of materials incorporated into the Project, and labor, tools, materials, and equipment used for the Work, consistent with the requirements of the General Conditions and as necessary for proper financial management under this Agreement. Subject to prior written notice, provide Owner reasonable access during normal business hours to Contractor's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data

relating to the Cost of the Work and the Contractor's fee. Preserve all such documents for a period of 3 years after the final payment by the Owner.

ARTICLE 10 – OTHER REQUIREMENTS

10.01 Workers' Compensation Insurance

A. By signing this Agreement, Contractor certifies that it provides workers' compensation insurance coverage for all employees employed on this Project pursuant to Tex. Lab. Code Section 406.096(a).

B. As required by Section 406.096(b), Contractor must require each Subcontractor to certify in writing to the Contractor that the Subcontractor provides workers' compensation insurance coverage for all of the employees it employs on this Project. Contractor must provide these certifications to the Owner within 10 days of the Effective Date of the Agreement.

10.02 Contracts Prohibited by Tex. Gov't Code Chapter 2155

A. Section 2155.004:

1. Section 2155.004 states that "a state agency may not accept a bid or award a contract that includes proposed financial participation by a person who received compensation from the agency to participate in preparing the specifications or request for proposals on which the bid or contract is based."

2. Under Section 2155.004, Government Code, Contractor certifies that the individual or business entity named in this bid or contract is not ineligible to receive the specified Contract and acknowledges that this Contract may be terminated and payment withheld if this certification is inaccurate.

B. Section 2155.006:

1. Section 2155.006 states that "a state agency may not accept a bid or award a contract, including a contract for which purchasing authority is delegated to a state agency, that includes proposed financial participation by a person who, during the five-year period preceding the date of the bid or award, has been: (1) convicted of violating a federal law in connection with a contract awarded by the federal government for relief, recovery, or reconstruction efforts as a result of Hurricane Rita, as defined by Section 39.459, Utilities Code, Hurricane Katrina, or any other disaster occurring after September 24, 2005; or (2) assessed a penalty in a federal civil or administrative enforcement action in connection with a contract awarded by the federal government for relief, recovery, or reconstruction efforts as a result of Hurricane Rita, as defined by Section 39.459, Utilities Code, Hurricane Katrina, or any other disaster occurring after September 24, 2005.

2. Under Section 2155.006, Government Code, Contractor certifies that the individual or business entity named in this bid or contract is not ineligible to receive the specified Contract and acknowledges that this Contract may be terminated and payment withheld if this certification is inaccurate.

10.03 Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations

A. Tex. Gov't Code Chapter 2252, Subchapter F, prohibits the award of governmental contracts to companies engaged in business with Iran, Sudan, or foreign terrorist organizations.

B. By signing this Agreement, Contractor certifies that it is not ineligible to be awarded this Contract under Chapter 2252, Subchapter F.

10.04 Prohibition on Contracts with Certain Companies that Boycott Israel

A. Tex. Gov't Code Chapter 2270 prohibits the award of governmental contracts to companies boycotting Israel.

B. By signing this Agreement, Contractor certifies that it does not boycott Israel and will not boycott Israel during the term of this Contract.

10.05 Certificate of Interested Parties: Contractor must complete and submit a Certificate of Interested Parties (Form 1295) to the Owner with the signed Agreement as required by Tex. Gov't Code Section 2252.908.

ARTICLE 11 – VENUE

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

ARTICLE 12 – PROJECTMATES REQUIREMENT

12.01 The Awarded Vendor will be required to use Projectmates software throughout the life of this project from award to closeout. The City will provide a license to be used by the Awarded Vendor at no cost. Projectmates by Systemates, Inc., is a construction management tool that allows users to manage the entire project life cycle from concept to closeout. All RFI's, Schedules, Daily Reports, Change Orders, Pay Requests, and any procedures related to contract management will be processed through Projectmates. The City reserves the right to rescind an award from a Vendor who refuses to use Projectmates during the life of the project. Such refusal will be noted and considered when awarding future projects.

ARTICLE 13 – FEMA CLAUSES

Attention is called to the fact that this project is eligible for Federal Funding thus the following clauses have been incorporated herein:

13.01 Termination for cause and for convenience by the grantee or sub-grantee including the manner by which it will be effected and the basis for settlement. (All contracts in excess of $10,000)

A. **Termination for Cause:** Pursuant to Federal Rule (B) above, when the City of Beaumont expends federal funds, the City of Beaumont reserves the right to immediately terminate any contract in excess of $10,000 resulting from this procurement process in the event of a breach or default of the agreement by Vendor in the event Vendor fails to: (1) meet schedules, deadlines, and/or delivery dates within the time specified in the procurement solicitation, contract, and/or a purchase order; (2) make any payments owed; or (3) otherwise perform in accordance with the contract and/or the procurement solicitation.

B. **Termination for Non-Appropriation of Funds for Multi-year or Multiple-year Contracts:** Performance by the City of Beaumont under the Contract for years subsequent to the current budget year may be dependent upon the appropriation and allotment of funds by the Texas State Legislature (the "Legislature"), allocation of funds by the Board of Trustees (the "Board"), and/or, if the Contract is funded fully or partially by Federal grant awards, the receipt of the Notice of Grant Award ("NOGA"). If the Legislature fails to appropriate or allot the necessary funds, the Board fails to allocate the necessary funds, and/or there is a change in the NOGA, then the District may terminate this Contract without further duty or obligation under the Contract.

C. **Termination for Convenience: T**he City of Beaumont also reserves the right to terminate the contract immediately upon written notice to Vendor for convenience, with or without cause, if the City of Beaumont believes in its sole discretion that it is in the best interest of the City of Beaumont to do so.

If the contract is terminated in accordance with any of the terms referenced in Section (B) above, the City of Beaumont shall compensate Vendor for any work performed and accepted and goods delivered and accepted by the City of Beaumont as of the termination date. Any award under this procurement process is not exclusive and the City of Beaumont reserves the right to purchase goods and/or services from other vendors when it is in the City of Beaumont's best interest.

13.02 **Debarment and Suspension (Executive Orders 12549 and 12689)**—A contract award (see 2 CFR 180.220) must not be made to parties listed on the government wide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

Pursuant to Federal Rule (E) above, when federal funds are expended by the City of Beaumont, Vendor certifies that during the term of an award for all contracts by the City of Beaumont resulting from this procurement process, Vendor certifies that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation by any federal department or agency.

13.03 **Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)—**Contractors that apply or bid for an award exceeding $100,000 must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award.

Pursuant to Federal Rule (F) above, when federal funds are expended by the City of Beaumont, Vendor certifies that during the term and after the awarded term of an award for all contracts by the City of Beaumont resulting from this procurement process, the vendor certifies that it is in compliance with all applicable provisions of the Byrd Anti-Lobbying Amendment (31 U.S.C. 1352). The undersigned further certifies that:

A. No Federal appropriated funds have been paid or will be paid for on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with the awarding of a Federal contract, the making of a Federal grant, the making of a Federal loan, the entering into a cooperative agreement, and the extension, continuation, renewal, amendment, or modification of a Federal contract, grant, loan, or cooperative agreement.

B. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions.

C. The undersigned shall require that the language of this certification be included in the award documents for all covered sub-awards exceeding $100,000 in Federal funds at all appropriate tiers and that all sub-recipients shall certify and disclose accordingly.

13.04 **Procurement of Recovered Materials —** Vendor agrees to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, where applicable. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR Part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds $10,000 or the value of the quantity acquired during the preceding fiscal year exceeded $10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery, and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

13.05 **Certification of Equal Employment Statement**

It is the policy of the City of Beaumont not to discriminate on the basis of race, color, national origin, gender, limited English proficiency or handicapping conditions in its programs. Vendor agrees not to discriminate against any employee or applicant for employment to be employed in the performance of this Contract, with respect to hire, tenure, terms, conditions and privileges of employment, or a matter directly or indirectly related to employment, because of age (except where based on a bona fide occupational qualification), sex (except where based on a bona fide occupational qualification) or race, color, religion, national origin, or ancestry. Vendor further agrees that every subcontract entered into for the performance of this Contract shall contain a provision requiring non-discrimination in employment herein specified, binding upon each subcontractor. Breach of this covenant may be regarded as a material breach of the Contract.

ARTICLE 14 – CONTRACT DOCUMENTS

14.01 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 Sheet Index on the Drawings.

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

D. 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).

E. 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.

14.02 Bidding Requirements and Informational Documents

A. The following Bidding Requirements are not Contract Documents:

1. Section 00 11 16 “Invitation to Bid.”
2. Section 00 21 13 “Instructions to Offerors.”
3. Section 00 41 13 “Bid Form.”
4. Section 00 41 16 “Bid Form Exhibit A.”
5. Section 00 43 13 “Bid Bond.”
6. Section 00 45 02 “Non-Collusion Certification.”
7. Section 00 45 03 “Conflict of Interest Questionnaire.”
8. Section 00 45 04 “State Sales Tax Requirements.”
9. Section 00 45 13 “Qualifications Statement.”

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

Owner: _____ *(typed or printed)*	Contractor: _____ *(typed or printed)*
By: _____ *(individual's signature)*	By: _____ *(individual's signature)*
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed* *(Attach evidence of authority to sign)*
Address for giving notice:	Address for giving notice:
_____	_____
_____	_____
_____	_____
Designated representative:	Designated representative:
Name: _____	Name: _____
Title: _____	Title: _____
Address:	Address:
_____	_____
_____	_____
_____	_____
Phone: _____	Phone: _____
Email: _____	Email: _____

END OF SECTION

00 61 13 PERFORMANCE BOND

Contractor as Principal Name: Mailing address (principal place of business):	**Surety** Name: Mailing address (principal place of business):
Owner Name: Mailing address (principal place of business):	Physical address (principal place of business): Telephone (Main): Telephone (Claims): Surety's state of incorporation:
Contract Project name and number: Contract Price: Effective Date of Contract:	***By submitting this bond, Surety affirms that it is licensed to provide and execute this bond and authorized to do business in Texas.***
Bond Bond Amount: 100 percent of Contract Price Date of Bond:	**Local Agent for Surety** Name: Mailing address (principal place of business): Telephone (Main):

(Date of Bond cannot be earlier than Effective Date of Contract)	***The address of the surety company to which any notice of claim should be sent may be obtained from the Texas Dept. of Insurance by calling the following toll-free number: 1-800-252-3439.***

Surety and Contractor, intending to be legally bound and obligated to Owner, do each cause this performance bond to be duly executed on its behalf by its authorized officer, agent, or representative. The Principal 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 the Contractor as Principal faithfully performs the Work required by the Contract then this obligation will be null and void; otherwise the obligation is to remain in full force and effect. Provisions of this bond shall be pursuant to the terms and provisions of Texas Government Code Chapter 2253 as amended and all liabilities on this bond shall be determined in accordance with the terms and provisions of said Chapter to the same extent as if it were copied at length herein. Venue lies exclusively in Jefferson County, Texas for any legal action.

Contractor as Principal	**Surety**
Signature: _____	Signature: _____
Name: _____	Name: _____
Title: _____	Title: _____
Email: _____	Email: _____
	(Attach Power of Attorney and place surety seal below)

END OF SECTION

00 61 16 PAYMENT BOND

Contractor as Principal Name: Mailing address (principal place of business):	**Surety** Name: Mailing address (principal place of business): Physical address (principal place of business): Telephone (Main): Telephone (Claims): Surety's state of incorporation:
Owner Name: Mailing address (principal place of business):	
Contract Project name and number: Contract Price: Effective Date of Contract:	***By submitting this bond, Surety affirms that it is licensed to provide and execute this bond and authorized to do business in Texas.***
Bond Bond Amount: 100 percent of Contract Price Date of Bond: (Date of Bond cannot be earlier than Effective Date of Contract)	**Local Agent for Surety** Name: 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 Dept. of Insurance by calling the following toll-free number: 1-800-252-3439.***

Surety and Contractor intending to be legally bound and obligated to Owner do each cause this payment bond to be duly executed on its behalf by its authorized officer, agent, or representative. The Principal 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 the Contractor as Principal pays all claimants providing labor or materials to Contractor or to a Subcontractor in the prosecution of the Work required by the Contract then this obligation will be null and void; otherwise the obligation is to remain in full force and effect. Provisions of the bond shall be pursuant to the terms and provisions of Texas Government Code Chapter 2253 as amended and all liabilities on this bond shall be determined in accordance with the terms and provisions of said Chapter to the same extent as if it were copied at length herein. Venue lies exclusively in Jefferson County, Texas for any legal action.

Contractor as Principal	**Surety**
Signature: _____	Signature: _____
Name: _____	Name: _____
Title: _____	Title: _____
Email: _____	Email: _____
	(Attach Power of Attorney and place surety seal below)

END OF SECTION

00 61 19 MAINTENANCE BOND

Contractor as Principal Name: Mailing address (principal place of business):	**Surety** Name: Mailing address (principal place of business):
Owner Name: Mailing address (principal place of business):	Physical address (principal place of business): Telephone (Main): Telephone (Claims): Surety's state of incorporation:
Contract Project name and number: Contract Price: Effective Date of Contract:	***By submitting this bond, Surety affirms it is authorized to do business and licensed to execute bonds in Texas.***
Bond Bond Amount: **25** percent of Contract Price Bond Duration: **365 calendar days after expiration of one-year correction period** Bond Date: *(Date of Bond cannot be earlier than Effective Date of Contract)*	**Local Agent for Surety** Name: Mailing address (principal place of business): Telephone (Main):

Surety and Contractor, intending to be legally bound and obligated to Owner do each cause this maintenance bond to be duly executed on its behalf by its authorized officer, agent, or representative. The Contractor 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 the Contractor faithfully performs maintenance work required by the Contract Documents then this obligation will be null and void; otherwise the obligation is to remain in full force and effect. Provisions of the bond shall be pursuant to the terms and provisions of the Contract Documents with regard to the continued maintenance of the Project for the period specified in the Contract Documents. All liabilities on this bond will be determined in accordance with the provisions of said Contract Documents to the same extent as if they were copied at length herein. Venue lies exclusively in Jefferson County, Texas for any legal action.	
Contractor as Principal Signature: _____ Name: _____ Title: _____ Email: _____	**Surety** Signature: _____ Name: _____ Title: _____ Email: _____ *(Attach Power of Attorney)*

END OF SECTION

00 61 20 MAINTENANCE BOND REQUIREMENTS

ARTICLE 1 – MAINTENANCE BOND REQUIREMENTS

1.01 Provide a maintenance bond that complies with the requirements of this Section. A maintenance bond is defined as a performance bond that extends the correction period for a specified period of time beyond the one-year correction period described in the General Conditions.

1.02 Provide a maintenance bond that begins at the end of the one-year correction period and continues for the period stated in Section 00 61 19 “Maintenance Bond.”

1.03 Provide a maintenance bond in the amount stated in Section 00 61 19 “Maintenance Bond.”

1.04 Provide a maintenance bond that meets the same requirements for bonds as the Contractor’s performance bond as described in the Contract Documents.

1.05 Surety for the maintenance bond must meet the same requirements for the performance and payment bonds as set forth in the General Conditions.

1.06 Indemnification provisions of the General Conditions apply to the maintenance bond period.

ARTICLE 2 – DOCUMENTATION

2.01 Provide a maintenance bond using the form provided in Section 00 61 19 “Maintenance Bond.”

2.02 Comply with the requirements of Section 01 70 00 “Execution and Closeout Requirements.”

ARTICLE 3 – CORRECTIVE ACTION DURING THE MAINTENANCE BOND PERIOD

3.01 Correct Defective Work during the one-year correction period in accordance with the General Conditions.

3.02 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.

3.03 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.

3.04 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.

3.05 Owner may correct Defective Work without notice to the Contractor in an emergency where delay would cause serious risk of loss or damage.

3.06 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.

3.07 Reimburse the Owner for engineering and special services required to be furnished by the Owner which are directly attributable to the corrective Work.

3.08 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.

ARTICLE 4 – INSURANCE REQUIREMENTS

4.01 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 70 01 NOTICE OF AWARD

Date: _____, 20_____

To: _____
(Bidder)
Address: _____

_____

Attention: _____

At its meeting held _____ the City Council of the City of Beaumont awarded your firm the contract for:

COLLIER'S FERRY PUMP STATION
BID NO. WU0222-14

Said Award being based on your apparent successful Bid dated _____ and bearing a total Bid Price of:

_____ Dollars ($_____)

Work to be performed under this contract is to be completed within **900** calendar days.

You must comply with the following conditions within fourteen (14) calendar days of the date of this Notice of Award, by _____, 20_____.

1. You must deliver to the Owner four fully executed counterparts of the Agreement. Each of the Contract Documents must bear your signature where indicated.

2. You must deliver with the executed Agreement, the executed Payment and Performance Bonds (with Surety's Power of Attorney attached) and the Insurance Certificates as specified in the Instructions to Bidders, the General Conditions (Article 5.2), and the Supplementary General Conditions.

Questions should be addressed to: John Pippins III, Water Utilities Design Manager at (409)785-4702.

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

Within fourteen (14) calendar days after you comply with these conditions, the Owner will return to you a fully executed copy of the Contract Documents.

CITY OF BEAUMONT, TEXAS

By: _____

Title: City Engineer

END OF SECTION

00 70 02 NOTICE TO PROCEED

Date: _____, 20_____

To: _____

Address: _____

_____

Contract for: COLLIER'S FERRY PUMP STATION, BID NO. WU0222-14

You are hereby notified that the Contract Time under the above Contract will commence on:

_____, 20_____.

By that date, you are to start performing your obligations under the Contract Documents. In accordance with the provisions for beginning and completion of the work in the section of the Contract Documents entitled Summary of Work, the Time and Date of Completion is:

900 Calendar after the date of commencement of the work specified above, or not later than

_____, 20_____.

Before you start any work at the site, Paragraph 2.5 of the General Conditions provides that you must study the Contract Documents and verify figures and field dimensions, and must report any observed errors or discrepancies. You must also submit to the Engineer all those documents called for in the section entitled Contractor Submittals in the Technical Specifications.

Also, before you may start any work at the site, you must:

1. **Notify Water Utilities Engineering at least 24 hours before work will commence.**
2. **Submit Shop Drawings for Approval.**
3. **Submit CPM Work Schedule.**
4. **Obtain TPDES/TCEQ General Construction Permit, Notice to Proceed, and Construction Site Notice (TXR150000).**

CITY OF BEAUMONT, TEXAS

By: _____

Title: City Engineer

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 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 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 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 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 Owner.

13. *Construction Manager at Risk (CMAR)*—The individual or entity selected by Owner to construct the Project using the Construction Manager at Risk project delivery method. The term Contractor means Construction Manager at Risk in the Contract Documents when the Construction Manager at Risk project delivery method is used.

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

15. *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.

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

17. *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.

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

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

20. *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.

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

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

23. *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 Article 15.

24. *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 Owner. Design Professional has responsibility for design and technical issues related to the Contract Documents.

25. *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.

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

27. *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.

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

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 Owner and the Project is ready for Final Payment.

31. *Guaranteed Maximum Price (GMP)*—The maximum amount to be paid by Owner for the sum of the Cost of the Work plus Contractor's fee as set forth in the Agreement, subject to increases or decreases for changes in the Work, when the Construction Manager at Risk project delivery method is used.

32. *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.

33. *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.

34. *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.

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

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

37. *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.

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

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

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

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

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

43. *Owner's Budget*—The amounted budgeted by Owner for the construction of the Project.

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

45. *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 Owner.

46. *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.

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

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

49. *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.

50. *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.

51. *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.

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

53. *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.

54. *Set-off*–A reduction in payment due to Contractor under Article 15.

55. *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.

56. *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 Contractor.

57. *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.

58. *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.

59. *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 Submittals accepted by Construction Manager. Submittals, whether approved or accepted by OPT, are not Contract Documents.

60. *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.

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

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

63. *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.

64. *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.

65. *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.

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

67. *Work*—The construction of the Project or its component parts as required by the Contract Documents. Work includes and is the result of performing and providing all labor, services, and documentation to construct the Project; providing all materials and equipment to be incorporated into the Project, and providing related services for testing, startup and commissioning, all as required by the Contract Documents.

68. *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 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 “Contractor shall...” before these words.

2. Unless specifically stated that action is to be taken by OPT or others, it is understood that the action described is a requirement of 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 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 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 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 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 OPT's Project Management Information System or other electronic media as required by the Contract Documents or approved by 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.

B. Evidence of insurance must include copies of the insurance policies, including all endorsements, and identification of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

2.02 Copies of Documents

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 Submittals;
3. Schedule of Values; and
4. Schedule of Anticipated Payments.

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

C. Owner will designate the specific individuals authorized to act as representatives of Owner and the limits of their authority regarding acting on behalf of 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 the protocols specified in Section 01 33 00 “Document Management.”

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 Contractor and coordinated with 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 Contractor and coordinated with Design Professional through 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 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 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 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 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 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 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 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 OPT to Contractor.

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

C. OPT may initiate a Modification to the Contract Documents through 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 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 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 in Article 6 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 Owner if this delay is concurrent with a delay, disruption, or interference attributable to or within the control of 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 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 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 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 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 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 Proposal 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; 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 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 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 Contractor's Team:

1. Take immediate corrective or remedial action as required by Paragraph 7.10; 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 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;
2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site, except Underground Facilities, that contain Technical Data; and
3. Technical Data contained in 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 are 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;

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

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

4. 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 do so is issued by Construction Manager.

C. Construction Manager is to notify OPT after receiving notice of a differing subsurface or physical condition from 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 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. 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 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. OPT is to take the following action after receiving notice from 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 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 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 Construction Manager and take the following action if Contractor uncovers or reveals a Hazardous Environmental Condition at the Site or adjacent areas used by Contractor's Team that was not created by 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 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 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 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.

D. 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.

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

F. Owner may exclude Contractor from the Site and exercise Owner's termination rights under Article 16 if Contractor fails to obtain or maintain 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 - General Provisions

A. Obtain and maintain insurance with coverage amounts equal to or greater than the amounts specified in Section 00 73 16 "Insurance Requirements" or greater where required by Laws and Regulations.

B. Obtain insurance from companies that are duly licensed or authorized in the state in which the Project is constructed to issue insurance policies and that have an A.M. Best rating of A--VIII or better.

C. Deliver evidence of insurance in accordance with Section 00 73 16 "Insurance Requirements" to Owner to demonstrate that Contractor has obtained and is maintaining the policies, coverages, and endorsements required by the Contract. Provide copies of these certificates to Owner and additional insured.

D. Furnish copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles upon request by Owner or any additional insured. Contractor

may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this paragraph.

E. OPT's failure to demand such certificates or other evidence of Contractor's full compliance with the insurance requirements or failure to identify a deficiency in compliance from the evidence provided is not a waiver of Contractor's obligation to obtain and maintain the insurance required by the Contract Documents.

F. Notify Owner if Contractor fails to purchase or maintain the insurance required by the Contract Documents. Do not perform any Work on the Project unless the required insurance policies are in effect. Owner may exclude Contractor from the Site and exercise Owner's termination rights under Article 16 if Contract fails to obtain or maintain the required insurance.

G. Owner may elect to obtain equivalent insurance to protect Owner's interests without prejudice to any other right or remedy if Contractor fails to obtain or maintain the required insurance. Owner may impose a reasonable Set-off against payments due under Article 15 to recover the cost of the insurance.

H. Owner does not represent that the insurance coverage and limits established in this Contract are adequate to protect Contractor or Contractor's interests.

I. The required insurance and insurance limits do not limit Contractor's liability under the indemnities granted to Owner's Indemnitees in the Contract Documents.

J. Provide for an endorsement that the "other insurance" clause will not apply to OPT where OPT is an additional insured shown on the policy. Contractor's insurance is primary and non-contributory with respect to any insurance or self-insurance carried by OPT for liability arising out of operations under this Agreement.

K. Include and list OPT and any other individuals or entities identified in the Section 00 73 16 "Insurance Requirements" as additional insureds on all policies except for the workers' compensation policy and Contractor's professional liability policy.

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 OPT. The resident superintendent or acceptable qualified assistant is to always be present when Work is being done. 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 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 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 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 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 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 Owner if Change Proposal is to be submitted. 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 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 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 OPT and members of Contractor's Team; or

2. Creates an obligation on the part of Owner to pay or to see to the payment of money due members of 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 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 7.10.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 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 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. This 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:

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 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, 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 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. **TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, AND IN ADDITION TO ANY OTHER OBLIGATIONS OF CONTRACTOR UNDER THE CONTRACT OR OTHERWISE, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE PERFORMANCE OF THE WORK, PROVIDED THAT ANY SUCH CLAIM, ACTION, LOSS, OR DAMAGE IS ATTRIBUTABLE TO BODILY INJURY, SICKNESS, DISEASE, OR DEATH, OR TO DAMAGE TO OR DESTRUCTION OF TANGIBLE PROPERTY (OTHER THAN THE WORK ITSELF), INCLUDING THE LOSS OF USE RESULTING THEREFROM BUT ONLY TO THE EXTENT CAUSED BY ANY NEGLIGENT ACT OR OMISSION OF CONTRACTOR'S TEAM.**

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 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.

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 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 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;
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 other 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 this other work in the Contract Price if this 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 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 this other work unless otherwise provided in the Contract Documents. 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 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 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, 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 issues communications to Contractor through Construction Manager except as otherwise provided in the Contract Documents.

9.02 Replacement of Owner's Project Team Members

A. Owner may replace members of 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 Article 15.

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 Article 6.

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. 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 OPT to the Contractor or members of 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 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 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 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 the Contract Documents.

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 the Contract Documents.

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 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 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 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 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 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 Contractor to complete the Work within the Contract Times and are the only adjustments to which 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 obligates Contractor to undertake Work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.02 Contract Amendments

A. Owner and Contractor may modify the terms and conditions of the Contract Documents without the recommendation of 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 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.

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.

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 through 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 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 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 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 denial under Article 12.

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. Any 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 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 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 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 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 on the basis of 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 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 Contractor for early payment of these materials and equipment. Cash discounts are to be credited to Owner if 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 OPT. Bids are to be opened in the presence of Construction Manager and other designated members for OPT. Provide copies of bids to Construction Manager to use in determining, with 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 rental rate book named in the Supplemental Conditions. 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 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 Cost paid with regard to 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.

E. Contractor's fee is determined in accordance with the Agreement when the Work is performed on a cost-plus basis.

F. Contractor's Fee is determined as follows for Work included in a Change Proposal.

1. Contractor's fee is 15 percent of the costs included in the Cost of the Work per Paragraph 13.01.C.1 for payroll cost and per Paragraph 13.01.C.2 for cost of materials and equipment furnished and incorporated in the Work.

2. 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 Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that performs the Work.

G. 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.

H. 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 Owner through Construction Manager.

B. Contractor agrees that:

1. The cash allowance is used to compensate 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 20 percent or more of the total Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by Contractor differs by more than 20 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 Contractor, provided these costs are approved by 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 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; or
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 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 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 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 sufficient 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.

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 Construction Manager on the Application for Payment form provided by 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 Article 13 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 Construction Manager;

l. Failure to provide Project photographs 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, 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 Contractor;

o. Costs for tests performed by Owner to verify that Work previously tested and found to be Defective has been corrected;

p. 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;

q. Payment would result in an over-payment of the Contract Price; or

r. 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. Owner is to pay 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. Owner is to pay the amount of payment recommended by Construction Manager within 30 days after receipt of the Application for Payment and accompanying documentation from 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 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 Contractor of 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. Owner is to pay the amount of final payment recommended by Construction Manager within 30 days after receipt of the final Application for Payment and accompanying

documentation from 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 sufficient skilled workers or suitable materials or equipment;

2. Failure to adhere to the Progress Schedule;

3. Failure of 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 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.

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. Contractor's Team and their personnel are not considered to be employees or agents of Owner. Nothing in this Agreement is to be interpreted as granting Contractor's Team the right or authority to make commitments for 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. 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 the county in which the Owner's home office is located unless specified elsewhere in the Contract Documents.

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.45 of the General Conditions consists of the following organizations:

1. City of Beaumont

   801 Main Street

   Beaumont, Texas 77701

2. Freese and Nichols, Inc. (FNI)

   Attn: Somnath Chilukuri, P.E.

   11200 Broadway St. Suite 2320

   Pearland, Texas 77584

B. Add the following definitions in Paragraph 1.01.A:

1. *Engineer* – The individual or entity named as such in the Agreement.

2. *Geotechnical Baseline Report (GBR)* -- The interpretive report prepared by or for Owner regarding subsurface conditions at the Site, and containing specific baseline geotechnical conditions that may be anticipated or relied upon for bidding and contract administration purposes, subject to the controlling provisions of the Contract, including the GBR’s own terms. The GBR is a Contract Document.

3. *Geotechnical Data Report (GDR)* – The factual report that collects and presents data regarding actual subsurface conditions at or adjacent to the Site, including Technical Data and other geotechnical data, prepared by or for Owner in support of the Geotechnical Baseline Report. The GDR’s content may include logs of borings, trenches, and other site investigations, recorded measurements of subsurface water levels, the results of field and laboratory testing, and descriptions of the investigative and testing programs. The GDR does not include an interpretation of the data. If opinions, or interpretive or speculative non-factual comments or statements appear in a document that is labeled a GDR, such opinions, comments, or statements are not operative parts of the GDR and do not have contractual standing. Subject to that exception, the GDR is a Contract Document.

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.03 Before Starting Construction

A. Add the following sentence to Paragraph 2.03.A.4:

"No construction shall begin until after Schedule of Anticipated Payments has been approved."

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

SC-3.01 Intent

A. Supplement Paragraph 3.01 by adding the following paragraphs:

"L. Order of Precedence

1. Notwithstanding any statements to the contrary contained elsewhere in the Contract Documents, the Contract Documents identified below are listed in Order of Precedence and any conflicting statement(s) contained in any document listed below must defer to the conflicting statement(s) contained in a document listed above it in the list below.

    a. Change Orders, with those of a later date having precedence over other Change Orders of an earlier date.

    b. Contract

    c. Addenda, with those of a later date having precedence over other Addenda of an earlier date.

    d. Supplementary Conditions.

    e. General Conditions.

    f. Drawings.

    g. Specifications.

    h. Geotechnical Baseline Report.

    i. Geotechnical Data Report.

M. In the event of an inconsistency between Drawings and Specifications, the requirements of the Drawings shall govern. In the event of an inconsistency between separate Drawings, the large-scale details shall govern over smaller scale details or details with no scale. In the event of an inconsistency between separate Specification sections, the conflict shall be resolved by the Engineer in accordance with reasonable interpretation of such documents."

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 (as rain equivalent) 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 1-inch of precipitation (as rain equivalent, based on the snow/rain conversion indicated in Exhibit A – Foreseeable Bad Weather Days.

b) Ambient outdoor air temperature at 11:00 a.m. (low temperature threshold) is equal to or less than 32 degrees Fahrenheit.

c) Ambient outdoor temperature at 3:00 p.m. (high temperature threshold) is equal to or greater than 100 degrees Fahrenheit.

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 Weather Service weather monitoring station at Beaumont/Port Arthur Southeast Texas Regional Airport (KBPT) (https://w1.weather.gov/data/obhistory/KBPT.html).

3) Contractor shall anticipate the number of foreseeable bad weather days per month indicated in the table in Exhibit A.

4) In each month, every bad weather day exceeding the number of foreseeable bad weather days established in the table in Exhibit A 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 45 “bad weather days” has been set for this Project. An extension of time due to “bad weather days” will be considered only after 30 “bad weather days” have been exceeded in a calendar year and 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 Owner or Contractor in delay claims.”

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

SC-5.03 Subsurface and Physical Conditions

A. Delete Paragraph 5.03 in its entirety and replace with the following:

“5.03 Subsurface and Physical Conditions

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

1. those reports of explorations and tests of subsurface conditions at or adjacent to the Site (other than any Geotechnical Data Report or Geotechnical Baseline Report) that contain Technical Data. Such reports are as follows:

None

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. Such drawings are as follows:

a. Drawings Title: None

b. Date of Drawings:

c. Technical Data in drawings upon which Contractor may rely:

3. Contractor may examine copies of reports and drawings identified immediately above that were not included with the Bidding Documents at 1350 Langham Road, Beaumont, Texas 77707 during regular business hours, or may request copies from Design Professional, at the cost of reproduction.

B. Underground Facilities: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of

Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.64.

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

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

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

4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

E. Geotechnical Baseline Report:

1. This Contract contains a Geotechnical Baseline Report ("GBR"), identified as follows: Collier's Ferry Pump Station Geotechnical Baseline Report, dated November 12, 2021, prepared by Freese and Nichols, Inc., Houston, Texas.. This Contract also contains a Geotechnical Data Report (GDR), identified as follows: Final Geotechnical Data Report Collier Raw Water Pump Station and Tunnel, dated July 22, 2021, prepared by Tolunay-Wong Engineers, Inc., Beaumont, Texas.

2. The GBR and GDR are incorporated as Contract Documents. The GBR and GDR are to be used in conjunction with other Contract Documents, including the Drawings and Specifications. If there is a conflict between the terms of the GBR and the GDR, the GBR's terms prevail.

3. The GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations (referred to here in the Supplementary Conditions as "Baseline Conditions"). These may include ground, geological, groundwater, and other subsurface geotechnical conditions, and baselines of anticipated Underground Facilities or subsurface structures.

4. The Baseline Conditions will be used to assist in the administration of the Contract's differing site conditions clause at locations where subsurface

conditions have been baselined. If a condition is baselined in the GBR, then only the pertinent Baseline Conditions will be used to determine whether there is a differing site condition; and no other indication of that condition in the Contract Documents or Technical Data, or of a condition that describes, quantifies, or measures a similar characteristic of the subsurface, will be used for the differing site condition determination.

5. The Baseline Conditions will not be used to make differing site conditions determinations at locations that have not been baselined in the GBR, or at any location with respect to subsurface conditions that the Baseline Conditions do not address. If Underground Facilities or Hazardous Environmental Conditions are expressly addressed in the Baseline Conditions, then comparison to such Baseline Conditions will be the primary means of determining (a) whether an Underground Facility was shown or indicated with reasonable accuracy, as provided in Paragraph 5.05 of the General Conditions, or (b) whether a Hazardous Environmental Condition was shown or indicated in the Contract Documents as indicated in Paragraph 5.06. of the General Conditions. As indicated in Paragraph 5.04 below, the GDR will be the primary resource for differing site conditions determinations in cases in which the GBR is inapplicable.

6. The descriptions of subsurface conditions provided in the GBR are based on geotechnical investigations, laboratory tests, interpretation, interpolation, extrapolation, and analyses. Neither Owner, Design Professional, nor any geotechnical or other consultant warrants or guarantees that actual subsurface conditions will be as described in the GBR, nor is the GBR intended to warrant or guarantee the use of specific means or methods of construction.

7. The behavior of the ground during construction depends substantially upon Contractor's selected means, methods, techniques, sequences, and procedures of construction. If ground behavior conditions are baselined in the GBR, they are based on stated assumptions regarding construction means and methods.

8. The GBR will not reduce or relieve Contractor of its responsibility for the planning, selection, and implementation of safety precautions and programs incident to Contractor's means, methods, techniques, sequences, and procedures of construction, or to the Work."

SC-5.04 Differing Subsurface or Physical Conditions

A. Delete Paragraph 5.04 in its entirety and replace with the following:

"5.04 Differing Subsurface or Physical Conditions

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

1. differs materially from conditions shown or indicated in the GBR; or

2. differs materially from conditions shown or indicated in the GDR, to the extent the GBR is inapplicable; or

3. differs materially from conditions shown or indicated in Contract Documents other than the GBR or GDR, to the extent the GBR and GDR are inapplicable; or

4. to the extent the GBR and GDR are inapplicable, is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate; or

5. to the extent the GBR and GDR are inapplicable, is of such a nature as to require a change in the Drawings or Specifications; or

6. to the extent the GBR and GDR are inapplicable, is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, within three (3) calendar days after becoming aware thereof and before further disturbing the subsurface conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.12), notify Owner and Design Professional in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

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

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

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

E. Possible Price and Times Adjustments:

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

    a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

    b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03 of the General Conditions; and

    c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraph 4.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

    a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or

    b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

    c. Contractor failed to give the written notice as required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment must be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

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

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
None		

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
None		

3. Copies of reports and drawings may be downloaded from the procurement website.

ARTICLE 6 – BONDS AND INSURANCE

SC-6.01 Performance, Payment, and Other Bonds

A. Supplement Paragraph 6.01.D of the General Conditions by adding the following subparagraph(s):

"1. Contractor must provide a warranty bond for equipment as specified. Surety company providing the warranty bond may be the same surety company that provides the performance bond for the Project. The term and amount of the bond will be as specified in the bond form. Bond must be written to cover the interest of the Contractor and Owner and be transferable to Owner at Final Completion."

"2. Contractor must provide a process performance bond in the full amount of the equipment cost as indicated in the amount shown for the equipment listed below and as described in the noted Specification Sections. This bond is to become effective the date of Substantial Completion for the equipment so designated in accordance with Paragraph 15.03, and will remain in effect for a period of 2 years after the date of Substantial Completion, except as provided otherwise by Laws or Regulations. Surety for the process performance bond must meet the same requirements as for performance and payment bonds set forth in Article 6. Specific requirements for these process performance bonds must be as established in the noted Specification Sections."

Specification Section	Description of Equipment	Bond Amount	Bond Duration

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.15 Indemnification

A. Supplement Paragraph 7.15 by adding the following paragraph:

"C. Contractor's obligations to indemnify or hold Owner's Indemnitees harmless against losses, damages, or expenses specified in these General Conditions shall be subject to the applicable limitations of Chapter 130 of the Texas Civil Practice and Remedies Code."

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

SC-13.01 Cost of the Work

A. Supplement Paragraph 13.01.C.4.d.1) by adding the following sentence:

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

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; FINAL COMPLETION

SC-15.03 Substantial Completion

A. The following work must be complete before the Project may be considered Substantially Complete:

1. The microtunnel and pump station are completely operable.
2. The access roadway and modifications to Pine St. are complete and in use.

END OF SECTION

EXHIBIT A – FORESEEABLE BAD WEATHER DAYS

Month	Number of Foreseeable Bad Weather Days in Month Based on Precipitation as Rain Equivalent (inches)	Ambient Outdoor Air Temperature (deg F)	
		Number of Foreseeable Bad Weather Days in Month Based on Low Temperature (at 11:00 a.m.)	Number of Foreseeable Bad Weather Days in Month Based on High Temperature (at 3:00 p.m.)
January	2	1	0
February	1	1	0
March	1	0	0
April	1	0	0
May	2	0	0
June	2	0	0
July	3	0	1
August	2	0	1
September	2	0	0
October	1	0	0
November	1	0	0
December	1	0	0
Note: 2” of sleet equals 1” of rain, 5” of wet, heavy snow equals 1” of rain, 15” of “dry” powder snow equals 1” of rain.			

END OF EXHIBIT A

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-VIII 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 Beaumont
   Attn: Water Utilities Department
   801 Main Street
   Beaumont, TX 77701

2. Freese and Nichols, Inc.
   Attn: Will Allanach, Risk Manager
   801 Cherry Street, Suite 2800
   Fort Worth, Texas 76102

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 10 days' notice will be given before cancellation, 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 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.

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	
State	Statutory
Applicable Federal (e.g., Longshore)	Statutory
Foreign Voluntary Workers' Compensation (Employer's Responsibility Coverage), if Applicable	Statutory
Jones Act (if applicable)	
Bodily Injury by Accident – Each Accident	$1,000,000
Bodily Injury by Accident – Aggregate	$1,000,000
Bodily Injury by Disease – Each Occurrence	$1,000,000
Bodily Injury by Disease – Aggregate	$1,000,000
Employers' Liability	
Each Accident	$1,000,000
Each Employee	$1,000,000
Policy Limit	$1,000,000

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
General Aggregate	$1,000,000 / Occurrence $5,000,000 / Aggregate
Products - Completed Operations	$1,000,000 / Occurrence $5,000,000 / Aggregate
Personal and Advertising Injury (Limit Per Person)	$1,000,000
Bodily Injury and Property Damage – Each Occurrence	$1,000,000
Limit Per Person – Medical Expense	$5,000
Personal Injury Liability coverage will include claims arising out of Employment Practices Liability, limited to coverage provided under standard contract.	$1,000,000
Property Damage Liability insurance will provide explosion, collapse, and underground coverage where applicable	$1,000,000
Watercraft Liability Policy. Coverage shall apply to all vessels	$1,000,000
Excess Liability, Umbrella Form to include coverage of Watercraft Liability. General Aggregate – Each Occurrence	$1,000,000

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:

Automobile Liability Insurance	Policy Limits
Bodily Injury	
Each Person	$1,000,000
Each Accident	$1,000,000
Property Damage	
Each Accident	$1,000,000
Combined Single Limit	
Combined Single Limit for Bodily Injury and Property Damage	$1,000,000

D. Contractor's Professional Liability Insurance:

1. Purchase and maintain applicable professional liability insurance if Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Contract and for a minimum of 2 years

after Substantial Completion. The policy must pre-date the commencement of furnishing services on the Project.

2. Provide the following coverage with not less than the minimum limits indicated:

Contractor's Professional Liability Insurance	Policy Limits
Each Claim	$
Annual Aggregate	$

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.

2.03 OWNER'S LIABILITY INSURANCE

A. Contractor is required to provide Owner's Protective Liability Insurance coverage for the same minimum amounts as the Contractor's liability insurance coverage, unless greater amounts are required by Laws and Regulations.

END OF SECTION

00 73 16.1 INSURANCE REQUIREMENT AFFIDAVIT

CITY OF BEAUMONT
INSURANCE REQUIREMENT AFFIDAVIT

To be Completed by Appropriate Insurance Agent

and submitted with bid proposal.

I, the undersigned Agent/Broker, certify that the insurance requirements contained in this bid document have been reviewed by me with the below identified Contractor. If the below identified Contractor is awarded this contract by the City of Beaumont, I will be able to, within ten (10) days after being notified of such award, furnish a valid insurance certificate to the City meeting all of the requirements defined in this bid.

_____ _____
Agent (Signature) Agent (Print)

Name of Agency/Broker: _____

Address of Agent/Broker: _____

City/State/Zip: _____

Agent/Broker Telephone #: (_____) _____

CONTRACTOR'S NAME: _____
(Print or Type)

NOTE TO AGENT/BROKER

If this time requirement is not met, the City has the right to invalidate the bid award and award the contract to the next lowest bidder meeting specifications. Should an awarded bid be invalidated the Contractor may be liable for breach of contract. If you have any questions concerning these requirements, please contact the Purchasing Manager for the City of Beaumont at (409) 880-3720.

END OF SECTION

CERTIFICATE OF INSURANCE

Form No. COB1
Edition Date: 12/12/2018

This form is for informational purposes only and certifies that policies of insurance listed below have been issued to insured named below and are in force at this time. Notwithstanding any requirements, term or condition of any contract or other document with respect to which this certificate may be issued or may pertain, insurance afforded by policies described herein is subject to all terms, exclusions and conditions of such policies.

Prior to the beginning of work, the vendor shall obtain the minimum insurance and endorsements specified. Agents must complete the form providing all requested information and submit by fax, U.S. mail or e-mail as requested by the City of Beaumont ("COB"). The endorsements listed below are required as attachments to this certificate; copies of the endorsements are also acceptable. PLEASE ATTACH ALL ENDORSEMENTS TO THIS FORM AND INCLUDE THE MATCHING POLICY NUMBER ON THE ENDORSEMENT. Only City of Beaumont certificates of insurance are acceptable; commercial carriers' certificates are not.

This certificate shall be completed by a licensed insurance agent:

Name and Address of Agency:

_____

Phone: ____/_____

Name and Address of Insured:

_____

Phone: ____/_____

Prime or Sub-Contractor?: _____

Name of Prime Contractor, if different from Insured:

_____

City of Beaumont Reference:

Project Name: _____

Project Location: _____

Managing Dept.: _____

Project Mgr.: _____

Insurers Affording Coverages:

_____
Insurer A

_____
Insurer B

_____
Insurer C

_____
Insurer D

INSR LTR	TYPE OF INSURANCE	POLICY NO.	POLICY EFF. DATE (MM/DD/YYYY)	POLICY EXP. DATE (MM/DD/YYYY)	LIMITS OF LIABILITY	
	Commercial General Liability Policy As defined in the Policy, does the Policy provide:				Each Occurrence	$
					General Aggregate	$
	☐ Yes ☐ No – Completed Operations/Products				Completed Operations/ Products Aggregate	$
	☐ Yes ☐ No – Contractual Liability				Personal & Advertising Injury	$
	☐ Yes ☐ No – Explosion				Deductible or Self Insured Retention	$
	☐ Yes ☐ No – Collapse					
	☐ Yes ☐ No – Underground					
	☐ Yes ☐ No – Contractors / Subcontractors Work					
	☐ Yes ☐ No – Aggregate Limits per Project Form - CG 2503 0509 or Equivalent ☐ Yes					
	☐ Yes ☐ No – Additional Insured Form (not construction) - CG 2010 1001 or Equivalent ☐ Yes					
	☐ Yes ☐ No – Completed Operations Additional Insured Form (construction only) - CG2037 1001 or Equivalent ☐ Yes					
	☐ Yes ☐ No – 30 Day Notice of Cancellation Form - CG 2804 1093 or Equivalent ☐ Yes					
	☐ Yes ☐ No – Waiver of Subrogation Form - CG 2404 0509 or Equivalent ☐ Yes					

INSR LTR	TYPE OF INSURANCE	POLICY NO.	POLICY EFF. DATE (MM/DD/YYYY)	POLICY EXP. DATE (MM/DD/YYYY)	LIMITS OF LIABILITY	
	Pollution / Environmental Impairment Policy				Occurrence	$
					Aggregate	$

INSR LTR	TYPE OF INSURANCE	POLICY NO.	POLICY EFF. DATE (MM/DD/YYYY)	POLICY EXP. DATE (MM/DD/YYYY)	LIMITS OF LIABILITY	
	Commercial Auto Liability Policy As defined in the Policy, does the Policy provide:				CSL	$
					Bodily Injury (Per Incident)	$
	☐ Yes ☐ No – Any Auto				Bodily Injury (Per Person)	$

	☐ Yes ☐ No – All Owned Autos				Property Damage (Per Accident)	$
	☐ Yes ☐ No – Non-Owned Autos					
	☐ Yes ☐ No – Hired Autos					
	☐ Yes ☐ No – Waiver of Subrogation - CA0444 0410 or Equivalent ☐ Yes					
	☐ Yes ☐ No – 30 Day Notice of Cancellation - CA0244 or Equivalent ☐ Yes					
	☐ Yes ☐ No – Additional Insured - CA2048 or Equivalent ☐ Yes					
	☐ Yes ☐ No – MCS 90					
INSR LTR	**TYPE OF INSURANCE**	**POLICY NO.**	**POLICY EFF. DATE (MM/DD/YYYY)**	**POLICY EXP. DATE (MM/DD/YYYY)**	**LIMITS OF LIABILITY**	
	Excess Liability ☐ Umbrella Form ☐ Excess Liability Follow Form				Occurrence	$
					Aggregate	$
	Workers Compensation & Employers Liability As defined in the Policy, does the Policy provide				☐ Statutory	
					Each Accident	$
	☐ Yes ☐ No – Waiver of Subrogation - WC420304				Disease - Policy Limit	$
	☐ Yes ☐ No – 30 Day Notice of Cancellation - WC420601				Disease - Each Employee	$
	Is a Builders Risk or Installation Insurance Policy provided? ☐ Yes ☐ No					$
	☐ Yes ☐ No – Is the City shown as loss payee/mortgagee?					
	Professional Liability As defined in the Policy, does the Policy provide:				Each Claim	$
	☐ Yes ☐ No – 30 Day Notice of Cancellation Retroactive Date:				Deductible or Self Insured Retention	$

AGENT CERTIFICATION:

THIS IS TO CERTIFY TO THE CITY OF BEAUMONT
that the insurance policies above are in full force and effect.

Name of Insurance Company:	Name of Authorized Agent:
Company Address:	Agent's Address:
City: State: Zip:	City: State: Zip:
Authorized Agent's Phone Number (including Area Code):	Original signature of Authorized Agent: X _____
	Date:

CERTIFICATE HOLDER:

City of Beaumont

P. O. Box 3827
Beaumont, Texas 77704-3827

DATE ISSUED: _____

_____
AUTHORIZED REPRESENTATIVE SIGNATURE
Licensed Insurance Agent

Printed Name: _____

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.

As defined by the Texas Labor Code, Chapter 269, Section 406.096(e), building or construction is defined as:

1. Erecting or preparing to erect a structure, including a building, bridge, roadway, public utility facility, or related appurtenance;
2. Remodeling, extending, repairing, or demolishing a structure; or
3. Otherwise improving real property or an appurtenance to real property through similar activities.

The employment of a maintenance employee who is not engaging in building or construction as the employer's primary business does not constitute engaging in building or construction.

END OF SECTION

00 73 43 WAGE RATE REQUIREMENTS

ARTICLE 1 – PAYMENT OF PREVAILING WAGE RATES

1.01 Contractor and Subcontractors employed on this Project must pay not less than the rates established by the Owner as required by Tex. Gov't Code Chapter 2258.

1.02 The minimum wage rates for various labor classifications as established by the Owner are included in Section 00 73 46 "Wage Determination Schedule."

ARTICLE 2 – PENALTY

2.01 In accordance with Section 2258.023(b), any Contractor or Subcontractor who violates the requirements of Chapter 2258 shall pay the Owner $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.

2.02 Failure to comply with the requirements of Chapter 2258 may subject the Owner, Contractor, or Subcontractor(s) to additional civil and criminal penalties.

ARTICLE 3 – RECORDS

3.01 In accordance with Section 2258.024, the Contractor and its Subcontractors, if any, shall keep a record showing:

A. The name and occupation of each worker employed by the Contractor or Subcontractor in the construction of the Work; and

B. The actual per diem wages paid to each worker.

3.02 This record shall be open at all reasonable hours to inspection by the officers and agents of the OPT.

ARTICLE 4 – ENFORCEMENT

4.01 Owner will enforce the provisions of this Contract related to the payment of prevailing wage rates as required by Chapter 2258, Subchapter C.

4.02 Owner may be required to withhold money forfeited or required to be withheld under Chapter 2258 from the payments to the Contractor. If required, these amounts will be withheld from payments to the Contractor through a Set-off in accordance with the General Conditions.

END OF SECTION

00 73 46 WAGE DETERMINATION SCHEDULE

"General Decision Number: TX20220061 01/07/2022

Superseded General Decision Number: TX20210061

State: Texas

Construction Type: Heavy

Counties: Hardin, Jefferson and Orange Counties in Texas.

HEAVY CONSTRUCTION PROJECTS (Industrial and Processing Plants, and Refineries)

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022, Executive Order 14026 generally applies to the contract. The contractor must pay all covered workers at least $15.00 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022, Executive Order 13658 generally applies to the contract. The contractor must pay all covered workers at least $11.25 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at www.dol.gov/whd/govcontracts.

Modification Number Publication Date
0 01/07/2022

* ASBE0022-001 06/28/2021

	Rates	Fringes
Insulator/asbestos worker (includes application of all insulationg materials, protective coverings, coatings and finishing to all types of mechanical systems)	$ 24.90	15.90

BRTX0001-009 06/01/2017

	Rates	Fringes
BRICKLAYER	$ 23.02	9.53

CARP2484-001 01/03/2000

	Rates	Fringes
MILLWRIGHT	$ 19.72	3.73

SHEE0054-001 04/01/2020

	Rates	Fringes
Sheet metal worker (Including HVAC Duct work)	$ 29.70	13.85

SUTX2000-003 02/11/2000

	Rates	Fringes
ELECTRICIAN (Including Low Voltage wiring)	$ 15.20	0.40
LABORER		

Common.....$ 10.00

PIPEFITTER (Including HVAC
work).....$ 13.20 0.34

Power Equipment Operator
CRANE.....$ 15.20 0.40

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors 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, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local),

a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union, which prevailed in the survey for this classification, which in this example would be Plumbers 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those

classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Division National Office Branch of Wage Surveys. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator

(See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

END OF SECTION

STATEMENT OF CITY CHARTER PROVISION ON CONFLICT OF INTEREST

The following provisions were adopted in an effort to avoid potential conflict of interest with prospective bidders and City employees or officers in the awarding of City contracts:

1. No officer, elected or appointed, or other employee of the City shall have a financial interest, direct or indirect, or by reason of ownership of stock or share exceeding one percent (1%) in a business entity contracting with the City. Nor shall such officer or employee be financially interested, directly or indirectly, in the sale to the City of any land, materials, supplies or services from such business entity, except on behalf of the City in his official capacity as an officer or employee.

2. Any willful violation of this provision shall constitute malfeasance in office and any officer or employee guilty thereof shall thereby forfeit their office or position.

3. Any violation of this section with the knowledge expressed or implied of the person or business entity contracting with the City shall render the contract involved **null and void.** (Beaumont City Charter, Article XVII, Section 9.)

I, _____(name) have read and hereby understand the aforementioned Beaumont City Charter provision prohibiting conflict of interest between City employees or officers and prospective bidders in the award of City contracts. I affirm, to the best of my knowledge and belief, that there is no conflict of interest between the herein stated person or business entity and any City officer or employee if a City contract is awarded. I further state that I have no outside interests that conflict or suggest a potential conflict of interest with the City. I understand that knowledge, express or implied, or concealment of such material fact could nullify and void any such City contract awarded.

If I am awarded this contract, I herein agree to report promptly any further situation that might involve or appear to involve me in any conflict of interest with the City.

SIGNED this the _____ day of _____, 20_____.

_____
Name

_____
Title

GENERAL CONDITIONS OF BIDDING
(Revised 12/13/19)

FAILURE TO COMPLY WITH THESE GENERAL CONDITIONS OF BIDDING MAY RESULT IN THE BID BEING DISQUALIFIED**.**

1. BIDDING:

A. All bids must be on blank forms furnished by the Purchasing Division, and must be written in ink or by typewriter. Pencil quotations will not be considered. The bid must be executed personally by the bidder, or if executed by an agent, a power of attorney or other evidence of his authority to act on behalf of the bidder must accompany the bid. If the bidder is a corporation, the certificate of corporate bidder must be executed under the corporate seal by some duly authorized officer of the corporation other than the officers signing the bid. By execution of the bid, the bidder accepts all general and special conditions of the contract and the specifications.

B. TIME & DATE: Formal bids must be in the office of the City Clerk by 2:00 P.M., local time, on the day bids are due, unless otherwise specified; an early postmark will not suffice. Be sure you have allowed ample time for postal delivery. The City will not be responsible for the delivery of your bid to the office of the City Clerk. If you choose to send your bid by postal delivery then it is recommended that you call the City Clerk's office to verify receipt of your bid prior the bid opening. **Formal bids may NOT be faxed or e-mailed.**

Informal bids are due at the date and time stated in the bid document. **Informal bids may be faxed.**

C. WITHDRAWAL OF BID**:** A bidder may withdraw his proposal before Council acceptance of his bid without prejudice to himself, by submitting a written request for its withdrawal to the City Clerk.

D. Bids should show net prices, extensions and net total. In case of conflict between unit price and extensions, the unit price will govern.

E. No change in price will be considered after bids have been opened.

F. Unless otherwise specified, any catalog or manufacturer's reference or brand name used in describing an item is merely descriptive, and not

restrictive, and is used only to indicate type, style or quality of material desired. If a bidder quotes on an article other than the one specified, which he considers comparable, the name and grade of said article must be specified in the bid and sufficient specifications and descriptive data must accompany same to permit thorough evaluation. In the absence of these qualifications, he will be expected to furnish the article called for.

G. If this bid is altered, any erasure or alteration of figures on the item on which the erasure or alteration is made must be initialed by signee of this bid.

H. Bids will not be considered in cases in which bidder quotes an item price and also an alternate price on the proposed substitute item, except in cases in which alternate bids are called for.

I. All bids are to be delivered not later than the time stated in the specifications, F.O.B. Beaumont, Texas unless otherwise stated in the specifications and/or bid form.

J. Bidders are invited to be present at the opening of bids. After opening, bids may be inspected in the Purchasing Division offices.

K. If there is an honest mistake in the bid, due to clerical errors, and the bidder calls attention thereto promptly, he will not be bound by the bid.

L. Where the mistake was a result of bidder's negligence, and City has no knowledge of the mistake when bids were opened, and contract awarded, he will not be released and shall be bound by the bid.

M. If a mistake is not discoverable and verifiable by the City, bidder's incorrect interpretation of Engineering specifications set forth in a construction contract will not release him from his obligations, once a contract has been awarded by City Council and bidder has received notice of such award.

N. Sealed formal bids due in the City Clerk's office will not be accepted through facsimile equipment.

2. TAXES:

A. The City is exempt from the Federal Excise and Transportation Tax, and the Limited Sales and Use Tax. Unless the bid form or specification specifically indicates otherwise, the price bid must be net exclusive of the above mentioned taxes, and will be so construed. A vendor desiring refunds of, or exemptions from taxes paid on merchandise accepted by the City must submit the proper forms. The Purchasing Manager, if satisfied as to the facts, will approve or issue the necessary certificates.

3. AWARD:

A. The City reserves the right to consider and make awards of bids on articles of similar nature that in all respects will serve the purpose for which the purchase is being made. The City reserves the right to be the sole judge as to whether such articles will serve the purpose.

B. Unless otherwise specified, the City reserves the right to accept or reject in whole or in part any bid submitted or to waive any informality in the best interest of the City.

C. Contractor is an independent contractor. Award of a contract does not create a joint venture between Contractor and the City.

4. BID DEPOSIT:

A. No bid deposit will be expected of bidder unless specifications expressly provide otherwise.

B. When specifications expressly call for a bid deposit, the deposit may be in the form of a cashier's check, cash, a certified check made payable to the City of Beaumont or a bond. The bond shall be executed by a surety authorized by the Texas State Insurance Commission and must be signed by both the surety and the bidder.

C. When specifications call for a bid deposit, it should be placed in a separate bid envelope and enclosed with your bid. Should your bid deposit not be acceptable to the City, your bid will be returned.

5. DELIVERIES;

A. Unless otherwise stated in the bid form or specification, deliveries must consist only of new and unused merchandise.

B. Full fare must be allowed and no charge made for packages.

C. In the event that deliveries of the supplies covered in the proposal are not made within the number of days specified, or in the event that the supplies delivered are rejected, and are not removed and replaced within the number of days specified in the official notice of rejection, the City reserves the right to purchase said supplied in the open market. Upon any such breach of contract, the City reserves the right to proceed against the successful bidder and/or the surety on this bond for any and all damages occasioned by the breach.

6. REJECTIONS:

A. Articles not in accordance with samples and specifications must be removed by the bidder at his expense. All disputes concerning quality of supplies delivered under this proposal will be determined by the City Purchasing Manager or his/her designated representative.

B. All articles enumerated in the proposal shall be subject to inspection or delivery by an officer designated for the purpose and if found inferior to the quality called for, or not equal in value to the department's samples, or deficient in weight, measurements, workmanship or otherwise, this fact shall be certified to the Purchasing Manager who shall have the right to reject the whole or any part of the same.

7. BILLING:

A. All bills are subject to approval by the Purchasing Manager.

8. PATENTS:

A. The contractor agrees to indemnify and hold harmless the City, the Purchasing Manager, and his/her assistants from all suits and actions of every nature and description brought against it or any of them, for or on account of the use of patented appliances, products or processes, and he shall pay all royalties and charges which are legal and equitable. Evidence of such payment or satisfaction shall be submitted, upon request of the Purchasing Manager, as a necessary requirement in connection with the final estimate for payment in which such patented appliances, products or processes are used.

9. CONDITIONS PART OF BID:

A. The general conditions of bidding defined herein shall be a part of the attached bid.

10. CONTRACT:

A. No formal contract will be executed. The following will comprise the contract between the City and the successful bidder:

i. Notice to Bidders,
ii. General Specifications,
iii. General conditions of bidding,
iv. The Bid Sheet(s),
v. Resolution awarding the bid.

B. In case of conflict, the specifications shall be controlling.

11. OSHA REQUIREMENTS:

A. The vendor or contractor hereby guarantees to the City of Beaumont, Texas, that all material, supplies and equipment as listed on the proposal, contract or Purchase Order meets the requirements, specifications and standards as provided for under the Federal Occupational Safety and Health Act of 1970, as amended and in force at the date hereof.

12. BIDS:

A. Bids must remain firm for thirty (30) days from the bid opening date to allow for award by Council, unless otherwise specified.

13. DISCOUNTS:

A. Prompt payment discounts will be considered in making the award provided the period of the discount offered is sufficient to permit payment within such period in the regular course of business (minimum 10 days). Prompt payment discounts will not be considered for contract purchases.

B. In connection with any discount offered, time will be computed from the date of receipt of supplies or services or from the date a correct invoice is received, whichever is the later date. Payment is deemed to be made on the date of mailing of the check.

14. DISCLOSURE FORMS:

A. **All forms must be signed and returned with your bid sheet**.

15. EXCEPTIONS:

A. If exceptions are being taken to any part of specifications, have them listed separately on your letterhead and manually sign it.

16. PROTEST PROCEDURES – Any actual or prospective bidder or proposer who believes they are aggrieved in connection with or pertaining to a bid or proposal may file a protest. The protest must be delivered in writing to the Purchasing Manager, in person or by certified mail, return receipt requested, prior to award. The written protest must include:

A. Name, mailing address, and business phone number the protesting party;

B. Appropriate identification of the bid or proposal being protested;

C. A precise statement of the reasons for the protest; and

D. Any documentation or other evidence supporting the protest and any alleged claims.

The Purchasing Division will attempt to resolve the protest, including at the Purchasing Manager's option, meeting with the protesting party. If the protest is successfully resolved by mutual agreement, written verification of the resolution, with specifics on each point addressed in the protest, will be forwarded to the Chief Financial Officer (CFO).

If the Purchasing Division is not successful in resolving the protest, the protesting party may request, in writing, that the protest be considered by the CFO. Applicable documentation and other information applying to the protest will be forwarded to the CFO, who will promptly review such documentation and information. If additional information is desired, the CFO may notify the necessary party or parties to the protest to provide such information.

If the CFO is not successful in resolving the protest, the CFO may forward to the City Manager a request for review. The decision of the City Manager will be final.

17. PUBLIC INFORMATION ACT:

A. Texas Government Code, Chapter 552, gives you the right to access government records; and an officer for public information and the officer's agent may not ask why you want them. All government information is presumed to be available to the public. Certain exceptions may apply to the disclosure of the information. Governmental bodies shall promptly release requested information that is not confidential by law, either constitutional, statutory, or by judicial decision, or information for which an exception to disclosure has not been sought.

B. To request information from this governmental body, please contact:

Tina Broussard, City Clerk
City Hall

Physical Address:

801 Main Street, Suite 125
Beaumont, TX 77701

Mailing Address:

P.O. Box 3827
Beaumont, TX 77704-3827

409-880-3740 Fax
409-880-3745 Phone

clerk.orr@beaumonttexas.gov

18. WEBSITE – Vendors are responsible for verifying all addenda to specifications downloaded from the City website.

19. INTERLOCAL AGREEMENT – Successful bidder agrees to extend prices to all entities that have entered into or will enter into joint purchasing interlocal cooperation agreements with the City of Beaumont. The City of Beaumont is a participating member of several interlocal cooperative purchasing agreements, as permitted under Chapter 791 of the Texas Government Code, with certain other political subdivision, authorizing participation in a cooperative purchasing program. The successful vendor may be asked to provide products/services based upon the bid price, to any other participant.

20. FORCE MAJEURE – Neither the City nor the Contractor shall be required to perform any term, condition or covenant of this contact so long as performance is delayed or prevented by force majeure.

21. FUNDING OUT – The State of Texas statutes prohibit the obligation and expenditure of public funds beyond the fiscal year for which a budget has been approved. Should, during the term of this contract, funds be withdrawn by the funding authority, a Force Majeure shall be deemed to exist, and this contract may be terminated without penalty or recourse by either party.

22. TERMINATION – This contract may be terminated by either party upon thirty (30) days' written notice.

END OF SECTION

CORPORATE RESOLUTION

I, _____ Secretary
(Name)

do hereby certify that a meeting of the Board of Directors of:

_____, duly called and held at _____
(Name of Corporation)

_____ in the City of _____,
(Address)

State of _____, on the _____ day of _____, 20____, at which time a quorum was present, the following resolution was duly adopted as the action of the Board, and is now in full force and effect:

Be It Resolved, that _____, _____
(Name of Individual) (Title)

is hereby empowered and authorized to enter into contract agreements and to sign bid proposals, contracts and other written documents as may be necessary to perform such agreements; and that signature on such documents shall be evidence of the full and complete obligation of the Corporation to the terms and conditions of such Contract Documents.

WITNESS MY hand and Seal of the Corporation this _____ day of _____, 20_____.

_____
(Name of Corporation)

By:_____ Secretary
(Signature)

END OF SECTION

Minority Business Enterprise Policy

The City of Beaumont is committed to encourage and promote the use of Minority Business Enterprises (MBE) in construction and professional service contracts.

The Beaumont City Council adopted a new MBE policy on September 12, 2006. Goals for participation in City construction and professional service contracts are 20% of contracts exceeding $50,000 and $25,000, respectively.

To assist the City in meeting its goals, we ask that you make a good faith effort to invite certified MBE's and Historically Underutilized Businesses (HUB) to participate in your bid process.

Please complete and submit with your bid the attached form indicating all certified subcontractors that you plan to use in this project. The successful bidder will be required to submit a final list of subcontractors and amount contracted upon completion of the project.

You may obtain the list of City certified contractors from the

following: City of Beaumont website:

http://beaumonttexas.gov/departments/purchasing/

City of Beaumont
Finance Department
P.O. Box 3827
801 Main, Room 320
Beaumont, TX 77701
Phone: 409-880-3183
Fax: 409-880-3132

If you have any questions concerning the inclusion of MBE's in City bids, please call the Purchasing Division.

CITY OF BEAUMONT

MINORITY BUSINESS ENTERPRISE (MBE) PROGRAM

I. POLICY STATEMENT

"Minority Business Enterprise" (MBE), or "Minority Business" means a business in which (a) at least fifty-one percent (51%) is owned by minority members, or in the case of a corporation, at least fifty-one percent (51%) of the stock is owned by minority members; and (b) the management and daily business operations are controlled by one or more such individuals.

It is the policy of the City of Beaumont to involve local Minority-Owned Businesses (MBEs) to the fullest extent allowable by State statute in the procurement process.

In order to maximize the number of certified MBEs, the City will accept the State of Texas certified Historically Underutilized Businesses (HUBs) to meet its utilization goals.

II. ELIGIBILITY & OWNERSHIP

Minority individuals means those individuals who are citizens of the United States (or lawfully admitted permanent residents) who are a member of one the groups listed below:

A. "Asian-Indian Americans" which includes persons whose origins are from India, Pakistan, Bangladesh, Sri Lanka, Bhutan, or Nepal.

B. "Asian-Pacific Americans" which includes persons whose origins are from Japan, China, Taiwan, Korea, Vietnam, Laos, Cambodia, the Philippines, Samoa, Guam, the U.S. Trust Territories of the Pacific, and the Northern Marianas.

C. "Black Americans" which includes persons having origins in any of the Black racial groups of Africa.

D. "Hispanic Americans" which includes persons of Mexican, Puerto Rican, Central or South America, or other Spanish culture or origin, regardless of race.

E. "Native Americans" which includes persons who are American Indians, Eskimos, Aleuts, or Native Hawaiians.

F. American Women, including all women of any ethnicity.

III. MBE DIRECTORY

The City will maintain a directory to facilitate identification of MBEs with capabilities relevant to general contracting requirements and to particular bid solicitations. The directory is available to bidders to assist in their efforts to meet the City's MBE participation goals.

IV. MBE ELIGIBILITY AND JOINT VENTURES INVOLVING MBEs

To ensure that the MBE program only benefits firms owned and controlled by minority individuals, the City of Beaumont shall certify the eligibility of MBEs by verifying all documentation submitted for MBE certification.

A. Determination of Ownership and Control

1. An eligible MBE shall be an independent business, and

   a. the ownership and control by minority persons shall be real, substantial, continuing, and shall go beyond the pro forma ownership of the firm as reflected in its ownership documents;

   b. the minority owners shall enjoy the customary incidents of ownership and shall share in the risks and profits commensurate with their ownership interests, as demonstrated by an examination of the substance rather than form or arrangements;

   c. recognition of the business as a separate entity for tax or corporate purposes is not necessarily sufficient for recognition as an MBE;

   d. in determining whether a potential MBE is an independent business, the City shall consider all relevant factors, including the date the business was established, the adequacy of its resources for the work of the contract, and the degree to which financial, equipment leasing, and other relationships with non-minority firms vary from industry practice.

2. The City shall safeguard from disclosure to unauthorized persons information that reasonably may be regarded as confidential business information, consistent with federal, State and local law.

V. APPLICATION UPDATE

A. Once certified, an MBE shall update its submission annually every two (2) years by submitting a new application or certifying that the application on file is still accurate. If at any time there is a change in ownership or control of the firm, the firm shall submit a new application within thirty (30) days of the change.

B. Failure to renew every two years will result in company being removed from the directory of certified MBE's.

VI. PERCENTAGE GOALS

A. Overall Goals

The overall goal for the City of Beaumont's MBE program is to achieve twenty percent (20%) utilization for construction contracts exceeding $50,000 and twenty percent (20%) utilization for professional services contracts exceeding $25,000.
These goals shall not constitute a fixed quota. MBE participation will be calculated

using the total dollar value of the contract awarded.

VII. MAINTENANCE OF RECORDS AND REPORTS

A. In order to monitor the progress of its MBE program, the City shall maintain a record keeping system which will identify and assess MBE contract awards and projected goals.

B. These records shall include as a minimum:

1. the number of contracts awarded to MBEs;
2. a description of the general categories of contracts so awarded;
3. the dollar value of contracts so awarded;
4. the percentage of the dollar value of all contracts awarded which were awarded to MBEs.

VIII. DECERTIFICATION PROCEDURE

A. Reasons for Decertification

The City reserves the right to decertify an existing MBE for any of the following reasons:

1. the firm's structure has changed to the extent that the business is no longer owned or controlled by an eligible person(s);
2. the business is no longer active;
3. the business is not financially responsible;
4. the business is not competent to do the work for which it was certified in accordance with generally accepted industry standards;
5. the firm has refused or failed without good cause to perform the work for which it was certified; and
6. the business has failed to comply with the City's recertification process.

CITY OF BEAUMONT
SCHEDULE OF MBE PARTICIPATION

_____
NAME

CERTIFIED MBE CONTRACTOR	*ADDRESS*	*TYPE OF WORK*	*AGREED PRICE*

The undersigned will enter into a formal agreement with MBE Contractors for work listed in this schedule conditioned upon execution of a contract with the City of Beaumont.

NOTE: 1. This schedule should be submitted with your bid.

_____
SIGNATURE

_____
TITLE

Certificate of Interested Parties Information (Form 1295)

Texas' New Certificate of Interested Parties (Form 1295) – How do you comply?

Does your Firm enter into contracts with governmental entities or state agencies in the state of Texas? If so, then be prepared to determine if you must complete and file a Form 1295 the next time your Firm submits a contract for professional services to be signed by a governmental entity or state agency in the state of Texas. If required to be filed, your contract cannot be approved until it is filed.

On September 1, 2015, §2252.908 of the Texas Government Code became effective. §2251.908 provides that on and after January 1, 2016, a governmental entity or state agency may not enter into certain contracts with a business entity unless the business entity submits a disclosure of interested parties (Form 1295) to the governmental entity or state agency at the time the business entity submits the signed contract to the governmental entity or state agency. This disclosure requirement applies to contracts with a governmental entity or state agency that either: (1) require an action or vote by the governing body of the entity or agency before the contract may be signed; or, (2) has a value of at least $1million.

The procedure for complying with this new law is as follows: (1) use the application on the Texas Ethics Commission's website (www.ethics.state.tx.us) to enter the required information to be included on Form 1295; (2) print a copy of Form 1295 and the separate certification of filing that contains a unique certification number; (3) sign the printed copy of Form 1295 and have your signature notarized; (4) file the completed Form 1295 and certification of filing with the governmental entity or state agency with which you are entering into the contract. The governmental entity or state agency then notifies the Texas Ethics Commission of receipt of the Form 1295 and the Texas Ethics Commission then will post the completed Form 1295 on its website for all to see.

CERTIFICATE OF INTERESTED PARTIES — FORM 1295

Complete Nos. 1 - 4 and 6 if there are interested parties.
Complete Nos. 1, 2, 3, 5, and 6 if there are no interested parties.

OFFICE USE ONLY

1 **Name of business entity filing form, and the city, state and country of the business entity's place of business.**

2 **Name of governmental entity or state agency that is a party to the contract for which the form is being filed.**

3 **Provide the identification number used by the governmental entity or state agency to track or identify the contract, and provide a description of the services, goods, or other property to be provided under the contract.**

4 Name of Interested Party	City, State, Country (place of business)	Nature of Interest (check applicable)	
		Controlling	Intermediary

5 Check only if there is NO Interested Party. ☐

6 **UNSWORN DECLARATION**

My name is _____, and my date of birth is _____.

My address is _____, _____, _____, _____, _____.
(street) (city) (state) (zip code) (country)

I declare under penalty of perjury that the foregoing is true and correct.

Executed in _____ County, State of _____, on the _____ day of _____, 20_____.
(month) (year)

_____
Signature of authorized agent of contracting business entity
(Declarant)

ADD ADDITIONAL PAGES AS NECESSARY

Form provided by Texas Ethics Commission www.ethics.state.tx.us Revised 12/22/2017

Must file online at www.ethics.state.tx.us/File

01 11 00 SUMMARY OF WORK

1.00 GENERAL

1.01 WORK INCLUDED

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 Contract Documents for the operation and maintenance of the Project.
6. Procure and install Owner-selected Allowance items and place them in operation.
7. The Contract Documents do not indicate or describe all of the 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 Engineer.

1.02 JOB CONDITIONS

A. City's Standard Form of Construction Agreement, and General Requirements apply to each Section of the Specifications.

B. Comply with all applicable state and local codes and regulations pertaining to the nature and character of the Work being performed.

1.03 DESCRIPTION OF WORK

A. Work is described in general, non-inclusive terms as:

1. Modification to existing structures as follows:
    a. Existing Lawson Pump Station Forebay
2. Construction of new structures and equipment as follows:
    a. Tunnel Launch Shaft at Lawson Pump Station
    b. Intermediate Tunnel Shaft
    c. Tunnel Launch Shaft/Colliers Raw Water Pump Station (RWPS) Wet Well
    d. Colliers RWPS Pumps, Valves, and Piping
    e. Colliers RWPS Electrical Building and Generator
3. Site Work, grading, paving, drainage, and roads
4. Yard piping
5. Electrical, instrumentation and controls

1.04 WORK UNDER OTHER CONTRACTS

A. The following items of work are not included in this Contract, but may impact construction scheduling, testing, and startup:

1. Raw Water Transmission Line to Pine Street SWTP.

B. In the case of a disagreement between the above list and those specified elsewhere in the Contract Documents, the Contractor is to base his Bid on the most expensive listing.

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 Engineer.

2. Pay claims for damages which result from the late completion of the Project or any specified Milestones.

1.05 WORK BY OWNER

A. No items of work are included by Owner.

1.06 OWNER-PROVIDED PRODUCTS

A. Owner will not purchase or provide any products to the Contractor on this project.

1.07 CONSTRUCTION OF UTILITIES

A. Utility companies, or their contractors, will provide new or enhanced utilities for this Project. Existing utilities will be used for this Project until the Utility company provides improvements to the service. 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. Contractor shall coordinate all work with the utility company.

2. Owner will pay for permits and for providing permanent power.

3. Coordinate and cooperate with others performing this Work.

4. Power utility will provide the construction to the point shown on the Drawings.

5. Provide conduit, pull boxes/manholes, and other appurtenances between the existing power pole and the utility transformer. The utility company will provide the transformer, meter and the conductors between the power pole and transformer. Provide the pad for the utility provided transformer. Provide the conduit, conductors and other appurtenances between the transformer and the automatic transfer switch unless the Contract Documents indicate otherwise.

6. 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.

7. Pay for temporary power including construction cost, meter connection, fees, and permits.

8. 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.
9. Pay for the power consumed until the Project has been accepted as Substantially Complete unless noted otherwise.

1.08 NOMINATED SUBCONTRACTOR (NOT APPLICABLE)

1.09 OCCUPANCY

A. As soon as any portion of the structure and equipment are ready for use, the Owner shall have the right to occupy or operate that portion upon written notice to the Contractor.

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.

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 insure the least inconvenience to the Owner and general public.

1.10 CONTRACTOR'S USE OF PROJECT SITE

A. Limit the use of project site for work and storage to the areas at the site designated on the drawings and approved by the Owner.

B. Coordinate on the use of premises with the Owner or Engineer.

C. Assume full responsibility for the protection and safekeeping of products stored at the site.

D. Store products to allow Owner access for maintenance and operations.

E. Obtain and pay for the use of any additional storage or work areas needed for construction.

F. Any damage to existing facilities, including contamination, caused by Contractor's personnel, visitors, materials or equipment, shall be repaired or corrected at the Contractor's expense.

G. No alcoholic substance or illegal substance shall be permitted on the site at any time.

H. No concealed or illegal weapons shall be permitted on the site at any time.

2.00 PRODUCTS

2.01 MATERIALS

A. Provide materials and products per the individual Sections of the Specifications.

3.00 EXECUTION

A. Perform all work in strict compliance with the Contract Documents.

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 **No. 1**

Unsuitable soils removal, disposal off-site, and replacement

1.04 DESCRIPTION OF ALTERNATES (NOT USED)

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 phrase “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; and
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.”

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. Submit a draft Application for Payment to the Construction Manager each month at least 20 days before the date established in the Agreement for Owner to make progress payments. 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.

B. Submit Applications for Payment to the Construction Manager after agreement has been reached on the draft Application for Payment with the Construction Manager.

C. 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" section on the Application for Payment form. If the Final Completion date shows the 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" section 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.

D. 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; and
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; or
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 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; and

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 since Owner’s council must approve final 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. 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.

C. Provide evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest.

D. 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.

E. 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 - Mobilization:

1. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

B. Item A-02 – Stormwater Pollution Prevention

1. Includes stormwater pollution prevention measures and all related ancillary facilities at three sites: Lawson Pump Station, Intermediate Shaft location, and Colliers Raw Water Pump Station.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

C. Item A-03 – Site Work

1. Includes fill and grading, clearing and grubbing, fencing, gravel, asphalt access road, and all related ancillary facilities.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

D. Item A-04 – Structural

1. Includes structural modifications at Lawson Pump Station, Colliers RWPS wet well, Electrical Building, concrete slabs, concrete pipe supports, and all related ancillary facilities.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

E. Item A-05 – Process Mechanical

1. Includes four submersible pumps, associated piping, valves, and fittings, wet well hatches, sluice gates, NPW piping, yard piping, flow meter, pipe supports, and all related ancillary facilities.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

F. Item A-06 – Electrical, Instrumentation and Controls

1. Includes full compensation for supplying all labor, equipment, and materials and installation of all electrical, instrumentation and SCADA improvements on the site associated with the work at the pump station. Including but not limited to conduit, duct banks, conductors, grounding, lightning protection, instrumentation conductors, automatic transfer switch, switchboard, variable frequency drives, generator, panelboards, step-down transformers, lighting poles and foundations, lighting, lighting contactors, control panels, instrumentation, SCADA cabinet and PLC, and all system modifications to the City's operator workstation and all miscellaneous electrical, instrumentation and conduits as specified on the plans, complete in place for a complete and operational system.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

G. Item A-07 – Tunneling

1. Includes all items necessary to construct 48-inch tunnel including two launch shafts, one intermediate shaft, associated manholes, and all related ancillary facilities.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

H. Item A-08 – HVAC

1. Includes four wall pack HVAC units for the Electrical Building at Colliers RWPS and all related ancillary facilities.

2. Measuring for payment is on a lump sum basis. Payment for mobilization will be based on the earned value of Work completed.

1.05 MEASUREMENT AND BASIS FOR PAYMENT FOR EXTRA WORK ITEMS AND ALLOWANCES

A. Item D-01 – Additional Flexbase Paving

B. Item D-02 – Additional Structural Excavation

C. Item D-03 – Additional Structural Backfill

D. Item D-04 – Additional Concrete

E. Item D-05 – Additional Concrete Grout in Place

F. Item D-06 – Additional Rebar

G. Item D-07 – Bid Allowance No. 1

Unsuitable soils removal, disposal off-site, and replacement

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.

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 waived 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.

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. 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 established for Category 5 Construction Surveying as established in the Manual of Practice of Land Surveying in 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 COORDINATION

A. Coordinate the efforts of various trades having interdependent responsibilities for Work.

B. Conceal ducts, pipes, wiring, and other non-finish items in finished areas, except as otherwise shown. Coordinate locations of concealed items with finish elements. Install access panel or doors where units requiring access for maintenance or operation are concealed behind finished surfaces.

C. Coordinate architectural reflected ceiling plans with the exact location of items installed in suspended ceilings. Request clarification from the Construction Manager prior to proceeding with fabrication or installation of an item if it appears that a conflict exists.

D. Coordinate the installation of items to be installed later, including:

1. Accepted alternates.

2. Products purchased using allowances.

3. Work by others.

4. Owner-supplied, Contractor-installed items.

E. Sequence, coordinate, and integrate the various elements of mechanical, electrical, and other systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical and electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction.
4. Coordinate the installation of required supporting devices, sleeves, embedded items, and other structural components to be set in concrete before concrete is placed.
5. Install systems, materials, and equipment to provide the maximum headroom possible where mounting heights are not detailed or dimensioned.
6. Coordinate the connection of systems with exterior underground and overhead utilities and services. Comply with the Laws and Regulations and requirements of franchise service companies. Provide required connection for each service.
7. Install systems, materials, and equipment to conform with approved Shop Drawings, Product Data, and Operation and Maintenance Data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Adjust routing of piping, ductwork, utilities, and location of equipment as needed to resolve spatial conflicts between the various trades. Document changes in the indicated routings in the Record Documents per Section 01 31 13 “Project Coordination.”
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
9. Install systems, materials, and equipment to facilitate servicing, maintenance, and repair or replacement of components.
10. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

1.19 CUTTING AND PATCHING

A. Perform cutting, fitting, and patching required to complete the Work or to:

1. Uncover Work to provide for installation of new Work or the correction of Defective Work.
2. Provide routine penetrations of non-structural surfaces for installation of mechanical, electrical, and plumbing Work.
3. Uncover Work that has been covered prior to observation by the Construction Manager.

B. Submit Notification by Contractor in accordance with Section 01 31 13 “Project Coordination” to the Construction Manager in advance of performing any cutting which affects:

1. Work of any other contractor or the Owner;

2. Structural integrity of any structure or system of the Project;
3. Integrity or effectiveness of weather exposed or moisture resistant structure or systems;
4. Efficiency, operational life, maintenance, or safety of any structure or system; or
5. Appearance of any structure or surfaces exposed occasionally or constantly to view.

C. Include in request:
1. Location and description of affected Work;
2. Reason for cutting, alteration, or excavation;
3. Effect on the Work of any separate contractor or Owner;
4. Effect on the structural or weatherproof integrity of the Work;
5. Description of proposed Work, including:
a. Scope of cutting, patching, or alteration;
b. Trades that will perform the Work;
c. Products proposed for use; and
d. Extent of refinishing to be performed.
6. Alternatives to cutting and patching;
7. Written authorization from any separate Contractor whose Work would be affected; and
8. Date and time Work will be uncovered or altered.

D. Inspect existing conditions prior to starting the Work, including elements subject to damage or movement during cutting and patching. Uncover elements where required for an adequate inspection. Notify the Construction Manager of any conditions that negatively impact the ability to perform cutting and patching. Contractor is deemed to have accepted the existing conditions and assumed the risk associated with completing the Work when cutting or patching is started after the inspection.

E. Provide adequate support to maintain the structural integrity of facilities, structures, or elements that could be affected by cutting, patching or installing new Work. Provide devices and methods to protect facilities, structures, or elements from damage that could be affected by Contractor's efforts. Provide protection from the weather for portions of the Project that may be exposed by cutting and patching.

F. Make cuts or penetrations using methods that prevent damage to other Work and provide proper surfaces for patching and repairs.

G. Fit and adjust installed products to comply with specified products, functions, tolerances, and finishes.

H. Patch or repair facilities, structures or elements to provide completed Work per the Contract Documents.

I. Fit Work air-tight to pipes, sleeves, ducts, conduit, and other penetrations through the surfaces. Where fire rated separations are penetrated, fill the space around the pipe with

materials with physical characteristics equivalent to fire resistance requirements of penetrated surface. Provide firestop inserts inside pipes, sleeves, ducts, conduit, and other penetrations when required by fire resistance requirements.

J. Patch finished surfaces and building components using new products specified for the original installation. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:

1. For continuous surfaces, refinish to the nearest intersection.
2. For an assembly, refinish the entire unit.

1.20 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.

1.21 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 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; and
   9. Contingency plan that will be used if the original schedule cannot be met.

C. Submit plan 2 weeks 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 Project Management Information System (PMIS) provided by the Construction Manager. Software for the PMIS is **ProjectMates** which 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.

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 1.05.B.

1.06 DOCUMENT NUMBERING

A. Assign a document number to the Contractor originated document to allow tracking of the document during the review process.

1. Assign the number consisting of a prefix, a sequence number, and a letter suffix. Prefixes will be as follows:

Prefix	Description
AP	Application for Payment
CP	Change Proposal
CTR	Certified Test Report
EIR	Equipment Installation Report
GD	Graphic Documentation
NBC	Notification by Contractor
O&M	Operation and Maintenance Manuals
PD	Product Data
RD	Record Data
RFI	Request for Information
SD	Shop Drawing
SCH	Schedule of Progress

2. Issue sequence numbers in chronological order for each type of document as directed by the Construction Manager.

3. Issue numbers for resubmittals that have the same number as the original document followed by an alphabetical suffix indicating the number of times the same document has been sent to the Construction Manager for processing. For example: SD-025 A represents Shop Drawing number 25 and the letter “A” designates this is the second time this document has been sent for review.

4. Clearly note the document number on each page or sheet of the document.

5. Correct assignment of numbers is essential since different document types are processed in different ways.

B. Include reference to the Drawing number and/or Specification Section, detail designation, schedule, or location that corresponds with the data submitted on the Document Transmittal form. Other identification may also be required, such as layout drawings or schedules to allow the reviewer to determine where a particular product is to be used.

1.07 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 01 40 00 to demonstrate compliance
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

1.08 Electronic Documents Protocol

A. The parties shall follow the provisions in this Section, referred to as the Electronic Documents Protocol (“EDP”), for exchange of electronic transmittals.

B. Basic Requirements:

1. Except as otherwise stated elsewhere in the Contract Documents, the OPT and Contractor will send and accept Electronic Documents sent by Electronic Means using the protocols provided in this Section.

2. 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.

3. 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:

    a. to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations;

    b. 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

    c. to comply with the notice requirements.

4. 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.

C. System Infrastructure for Electronic Document Exchange:

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, 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. 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.

D. 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 impair 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 Schedule in Native 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 Section.

3. 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.

E. Requests by Contractor for Electronic Documents in Other Formats:

1. Release of any Electronic Documents developed during the design process (including Contract Documents, Technical Data, Drawings, and computer models) in formats other than those identified in this Section will be at the discretion of the OPT.

2. To the extent determined by OPT, release of Electronic Documents and other project information requested by Contractor ("Request") in formats other than those identified in this Section will be subject to the provisions of 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 or electronic computer model solely for Design Professional's purposes and not for any construction processes, 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 Contractor waives any claims against the Design Professional or Owner arising from use of data in Electronic Documents covered by the Request.

c. **CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS THE 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 THE 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 the Contractor's subcontractors. Contractor warrants that subsequent use by the Contractor's subcontractors complies with all terms of the Contract Documents and the Owner's response to Request.

3. In the event that Owner elects to provide or directs 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, 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 in accordance with the General Conditions.

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 in the Document Register required by Section 01 33 00 "Document Management" 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 1.09.

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 1.08.

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.**F**.

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 1.11.C.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 Section 01 33 00 "Document Management" 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.E.

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 1.02may 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 digital 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 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. JCC1-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 of 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 making revisions to 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 and two DVDs of the video recording 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 two color prints of each photograph and a digital copy on a DVD of each photograph taken.

D. Identify each print on back with:

1. Name of the Project.

2. Date, time, location, and orientation of the exposure.

3. Description of the subject of photograph.

E. Submit photograph in clear plastic sheets designed for photographs. Place only one photograph in each sheet to allow the description on the back to be read without removing the photograph.

F. Final photographs are to include two 8-inch x 10-inch glossy color prints for each of the 10 photographs selected by the Construction Manager. These photographs are in addition to normal prints.

2.02 VIDEO RECORDING

A. Provide video recordings in digital format on a DVD that can be played with Windows Media Player in common format 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 sufficient 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 sufficient 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. Perform the Work as required to complete the entire Project within the Contract Times and in the sequence stipulated below:

Sequence No.	Description	Predecessor Condition
1	Roadwork on Pine St. and Access Roadway	Installation of 48” raw water pipeline at Pine St. (by others)
2	Remaining work at Collier’s Ferry Pump Station	Roadwork on Pine St. and Access Roadway

B. Consider the sequences, duration limitations, and governing factors outlined in this Section to prepare the schedule for the Work.

C. Perform the Work not specifically described in this Section as required to complete the entire Project within the Contract Times.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 40 00 QUALITY MANAGEMENT

PART 1 - GENERAL

1.01 OVERVIEW

A. Quality management refers to the overall process of delivering a completed Project to the Owner that complies with the requirements of the Contract Documents. Quality management applies to documentation, products, services and the Work.

B. The Contractor is responsible for the quality of documentation, products, services and the Work provided.

1. Contractor is to integrate quality control procedures into the execution of the Work that are adequate to produce a Project that meets the requirements of the Contract Documents while minimizing loss of time and increased cost. Contractor is solely responsible for time and cost impacts of correcting Defective Work.

2. Contractor is to provide all testing and inspection required to control the quality of the Work in progress to determine that completed Work will comply with the requirements of the Contract Documents.

3. Contractor is to provide verification or acceptance testing as required by the Contract Documents to demonstrate that the completed Work complies with the requirements of the Contract Documents, except for those test that the OPT has determined are to be conducted independent of the Contractor and identified as OPT testing in the Owner's Quality Management Plan.

1.02 STANDARDS

A. Provide testing laboratories that comply with the American Council of Independent Laboratories (ACIL) "Recommended Requirements for Independent Laboratory Qualifications."

B. Perform testing per recognized test procedures as listed in the various Sections of the Specifications, standards of the State Department of Transportation, ASTM International (American Society for Testing and Materials), or other testing associations. Perform tests in accordance with published procedures for testing issued by these organizations.

1.03 DOCUMENTATION

A. Provide documentation which includes:

1. Contractor's Quality Management Plan that establishes the methods of ensuring compliance with the Contract Documents. Submit this plan as Product Data per Section 01 31 13 "Project Coordination."

2. A statement of qualifications for any proposed testing laboratory that includes a list of the engineers and technical staff that will provide testing services on the Project, descriptions of the qualifications of these individuals, list of tests that can be performed, equipment used with date of last certification, and a list of recent projects for which testing has been performed with references for those projects.

3. Certified Test Reports for products to be incorporated into the Project. Provide reports to indicate that the proposed products comply with the Contract Documents or indicate that the proposed products do not comply with the Contract Documents and why those products do not comply. Submit Certified Test Reports as part of a Shop Drawing submitted per Section 01 33 02 “Shop Drawings.”

4. Certified Test Reports for inspections and testing required in this Section and in other Sections of the Specifications. Provide reports to indicate that the Work complies with the Contract Documents or indicate that the Work does not comply with the Contract Documents and why the Work does not comply. Submit these test reports on forms provided by the Construction Manager per Section 01 33 00 “Document Management.”

5. Certified Test Reports of Defective Work and Certified Test Reports documenting that successful corrective action has produced Work that complies with the Contract Documents. Construction Manager will maintain a Defective Work register. Progress on correction of Defective Work will be discussed at progress meetings as described in Paragraph 1.05.E. The final Defective Work register will be incorporated into closeout documentation required per Section 01 70 00 “Execution and Closeout Requirements” as a record that all Defective Work has been corrected.

6. Certified Test Reports of Defective Work and Certified Test Reports documenting that successful corrective action has produced Work that complies with the Contract Documents. Maintain a register listing Defective Work and record when corrective action has produced Work that complies with the Contract Documents. Present this Defective Work register as part of the Quality Report at progress meetings as described in Paragraph 1.05.E. Incorporate this register in the closeout documentation per Section 01 70 00 “Execution and Closeout Requirements” to demonstrate that all Defective Work has been corrected.

1.04 OWNER’S QUALITY MANAGEMENT ACTIVITIES

A. OPT may perform its own verification testing independent of the Contractor. Owner’s Quality Management Plan describes the OPT’s anticipated verification testing program for this Project. The preliminary testing plan is shown in Paragraph 3.05. This plan outlines the anticipated testing in general terms and may not reflect the actual testing performed by the OPT. Actual testing will depend on the Contractor’s means, methods, and procedures of construction which will not be known until the Contractor submits the Contractor’s Quality Control Plan (CQCP) to the OPT. There is no guarantee that all testing in the preliminary OQMP included in the Bidding/Proposal Documents will be performed by the OPT. Contractor will arrange and pay for all production control testing deemed necessary by the Contractor to produce quality results.

B. Quality management activities of the OPT are for verifying the results of the Contractor’s Work complies with the requirements of the Contract Documents. Performance or non-performance of verification activities by the OPT:

1. Does not relieve the Contractor of its responsibility to provide Work and furnish products that comply with the requirements of the Contract Documents;

2. Does not relieve the Contractor of its responsibility to provide adequate quality control measures to produce quality documents, products, services or Work;

3. Does not relieve the Contractor of its responsibility for damage to or loss of Work or products before OPT's acceptance; and

4. Does not affect the continuing rights of the Owner after OPT's acceptance of the completed Work.

C. The Work is subject to OPT's observations or testing at any time. Products which have been tested or inspected and accepted by the OPT at a supply source or staging area may be inspected or tested again by the OPT before, during, or after incorporation into the Work and rejected if products do not comply with the Contract Documents. Verification testing performed by the OPT will be paid for by the Owner, except for testing related to Defective Work as discussed in Paragraph 3.03.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Review the OQMP and provide a Contractor's Quality Control Plan (CQCP) outlining testing to be provided by the Contractor per Paragraph 1.07.

B. Implement the CQCP to provide Work that complies with the requirements of the Contract Documents.

1. Provide quality documents meeting the requirements of the Contract Documents.

2. Provide services meeting the requirements of the Contract Documents.

3. Provide the services of a Construction Materials Inspection and Testing (CMIT) provider meeting the requirements of this Section to provide testing required by the Contract Documents to demonstrate that products proposed for the Project in Shop Drawings and Product Data fully comply with the Contract Documents.

4. Inspect and test products to be incorporated into the Project to identify defects before installing them. Do not install Defective products. Conspicuously mark Defective products and remove from the Site. If products are installed before the defect is recognized, remove the Defective products, mark them as Defective and remove them from the Site when the defect is recognized.

5. Integrate production quality control measures into construction activities to produce Work meeting the requirements of the Contract Documents. Inspect self-performed Work and the Work of Subcontractors and Suppliers to identify defects. Correct or replace Defective Work.

6. Provide facilities, equipment, and Samples required for inspections and tests.

a. Give the Construction Manager adequate notice before proceeding with Work that would interfere with inspections or testing.

b. Notify the Construction Manager and CMIT provider prior to the time that testing is required, providing adequate lead time to allow arrangements for inspections or testing to be performed.

c. Do not proceed with Work that would impact the ability to correct defects, or with Work that would require that it be removed to correct defects, until testing is complete, and test results indicate that the corrected Work is acceptable.

d. Provide safe access for all CMIT activities, including those to be conducted as part of the Owner's Quality Management Program.

e. Cooperate fully with the performance of sampling, inspection, and testing. Provide personnel to assist with sampling or to assist in making inspections and field tests.

f. Provide Samples and products in adequate quantities for testing at the Site or at the production source of the product for testing.

g. Provide facilities required to store and cure test Samples.

h. Provide calibrated scales and measuring devices for OPT's use in performing inspections and testing.

i. Provide adequate lighting to allow OPT observations.

j. Make Contract Documents available to testing agencies when requested.

C. Perform tests as indicated in Contract Documents. All verification testing is to be observed by the Construction Manager or its designated representative.

D. Submit test reports to the Construction Manager.

E. Provide an update on quality control activities performed the previous month and planned for the coming month at monthly progress meetings required by Section 01 31 13 "Project Coordination."

F. Determine testing or inspections required to implement the CQCP. Include costs for additional testing and inspections required to meet Contractor's quality control obligations in the Contract Price.

1.06 CONTRACTOR'S QUALITY CONTROL MANAGER

A. Provide a Quality Control Manager for the Project. The Quality Control Manager must have authority to reject Defective Work, redirect the efforts of the Contractor, Subcontractor and Suppliers to correct Defective Work and implement steps to prevent future Defective Work.

B. The resident superintendent or an approved assistant can serve as Quality Control Manager, provided other duties will allow adequate time to serve in this capacity.

1.07 CONTRACTOR'S QUALITY CONTROL PLAN

A. Provide a CQCP that describes testing and inspections for Work performed at the Site and at remote locations. Include Work by Subcontractors and Suppliers. The CQCP is to include:

1. A description of the quality control organization, including an organization chart showing lines of authority to control the quality of Work;

2. Documentation describing name, qualifications (in resume format), duties, responsibilities, and level of authority of the Quality Control Manager.;

3. The name, qualifications (in resume format), duties, responsibilities, and authorities of other persons assigned a quality control function;

4. Procedures for scheduling, reviewing, certifying, and managing documentation including documentation provided by Subcontractors and Suppliers;
5. Control, verification, and acceptance testing procedures for each specific test. Include:
    a. Name of tests to be performed,
    b. Specification paragraph requiring test,
    c. Parameters of Work to be tested,
    d. Test frequency,
    e. Persons responsible for each test, and
    f. Applicable industry testing standards and laboratory facilities to be used for the test;
6. Incorporate the testing specified in the OQMP into the CQCP, specifically identifying the tests or inspections that will be provided by the OQMP;
7. Procedures for tracking and documenting quality management efforts per Paragraph 1.03.
8. Reporting procedures which incorporate the use of forms provided by the Construction Manager.
9. The name of the proposed testing laboratories along with documentation of qualifications per Paragraph 1.03.

B. Use the Contractor's Quality Control Plan Checklist provided by the Construction Manager to review the CQCP before submitting and include a copy of the completed checklist with the CQCP. Do not begin Work until the CQCP is accepted. Submit an interim plan covering only the portion of Work to be performed if the Contractor plans to begin Work prior to submitting the complete CQCP for the Project. Do not begin Work on other parts of the Project until the complete CQCP is accepted.

C. Meet with the OPT 7 days after CQCP is submitted and before start of construction to discuss the CQCP.

D. Notify the Construction Manager of any changes to the CQCP or quality control personnel.

1.08 CONTRACTOR'S USE OF OWNER'S TEST REPORTS

A. Contractor will receive copies of all test reports documenting Owner's verification tests. Contractor is entitled to rely on the accuracy of these tests results and use these as part of its quality control efforts.

B. Contractor may submit a Change Proposal if the Owner's testing program deviates significantly from the OQMP. Contractor must demonstrate that actual testing and inspection costs were incurred implementing the CQCP as a result of OPT's decision to not provide testing described in the OQMP.

1.09 LIMITATION OF AUTHORITY OF THE TESTING LABORATORY

A. The testing laboratory representatives are limited to providing testing services and interpreting the results of the test performed.

B. The testing laboratory is not authorized to:

1. Alter the requirements of the Contract Documents;
2. Accept or reject any portion of the Work;
3. Perform any of the duties of the Contractor; or
4. Direct or stop the Work.

1.10 TEST REPORTS

A. Certified Test Reports are to be prepared for all tests.

1. Tests performed by testing laboratories may be submitted on their standard test report forms if acceptable to the OPT using the process directed by the Construction Manager. These reports must include the following:
    a. Name of the Owner, Project title and number, and name of the Contractor;
    b. Name, address, and telephone number of the laboratory;
    c. Name and signature of the laboratory personnel performing the test;
    d. Description of the product being sampled or tested;
    e. Date and time of sampling, inspection, and testing;
    f. Date the report was issued;
    g. Description of the test performed;
    h. Weather conditions and temperature at time of test or sampling;
    i. Location at the Site or structure where the test was taken;
    j. Standard or test procedure used in making the test;
    k. A description of the results of the test;
    l. Statement of compliance or non-compliance with the Contract Documents; and
    m. Interpretations of test results, if appropriate.
2. Submit reports on tests performed by Contractor, Subcontractors, or Suppliers on the as directed by the Construction Manager.
3. OPT will prepare test reports on tests performed by the OPT.

B. Submit test reports as directed by the Construction Manager within 24 hours of completing the test. Flag tests reports with results that do not comply with Contract Documents for immediate attention. Notify the Construction Manager using acceptable means other than the test report, immediately of any test that fails to comply with the Contract Documents.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Handle and protect test specimens of products and construction materials at the Site in accordance with recognized test procedures. Provide facilities for storing, curing, and processing test specimens as required by test standards to maintain the integrity of

Samples. Transport test specimens in a manner to prevent damage to specimens while in transit.

PART 2 - PRODUCTS

2.01 TESTING APPARATUS

A. Furnish testing apparatus and related accessories necessary to perform the tests.

2.02 SAMPLE PRODUCTS

A. Provide Samples of products in adequate quantity for testing.

PART 3 - EXECUTION

3.01 IMPLEMENTING CONTRACTOR'S QUALITY CONTROL PLAN

A. Perform quality control observations and testing as required in each Section of the Specifications and where indicated on the Drawings.

B. Include the following phases for each definable work task. A definable work task is one which is separate and distinct from other tasks, has separate control requirements, may be provided by different trades or disciplines, or may be work by the same trade in a different environment.

1. Planning Phase: Perform the following before beginning each definable work task:

a. Review the Contract Documents.

b. Review documents the Contractor will submit and determine that they are complete in accordance with the Contract Documents.

c. Check to ensure that all materials and/or equipment have been tested, submitted, and approved.

d. Examine the work area to ensure that all required preliminary Work has been completed and complies with the Contract Documents.

e. Examine required materials, equipment, and sample Work to ensure that they are on hand, conform to Contract Documents, Shop Drawings and Product Data, and are properly stored.

f. Review requirements for quality control inspection and testing.

g. Discuss procedures for controlling quality of the Work. Document construction tolerances and workmanship standards for the work task.

h. Check that the portion of the plan for the Work to be performed incorporates document review comments.

i. Discuss results of planning phase with the Construction Manager. Conduct a meeting attended by the Construction Manager, Quality Control Manager, superintendent, other quality control personnel as applicable, and the foreman responsible for the work task. Instruct applicable workers as to the acceptable level of workmanship required to meet the requirements of the Contract

Documents. Document the results of the planning phase actions by separate meeting minutes prepared by the Quality Control Manager and attached to the quality control report.

j. Do not move to the next phase unless results of investigations required for the planning phase indicate that requirements have been met.

2. Work Phase: Complete this phase after the planning phase:

a. Notify the Construction Manager at least 1 week in advance of beginning the Work and discuss the review of the planning phase effort to indicate that requirements have been met.

b. Check the Work to ensure that it is in full compliance with the Contract Documents.

c. Verify adequacy of controls to ensure full compliance with Contract Documents. Verify required control inspection and testing is performed.

d. Verify that established levels of workmanship meet acceptable workmanship standards. Compare with required Sample panels as appropriate.

e. Repeat the work phase for each new crew to work on-site, or any time acceptable specified quality standards are not being met.

3. Follow-Up Phase: Perform daily checks to ensure control activities, including control testing, are providing continued compliance with contract requirements:

a. Make checks daily and record observations in the quality control documentation.

b. Conduct follow-up checks and correct all defects prior to the start of additional work tasks that may be affected by the Defective Work. Do not build upon nor conceal Defective Work.

c. Conduct a review of the Work at least 1 month prior to the expiration of the correction period prescribed in the General Conditions with the OPT. Correct defects as noted during the review.

C. Conduct additional planning and work phases if:

1. The quality of on-going Work is unacceptable;

2. Changes are made in applicable quality control staff, on-site production supervision, or crews;

3. Work on a task is resumed after a substantial period of inactivity; or

4. Other quality problems develop.

3.02 DEFECTIVE WORK

A. Immediately correct any Defective Work or notify the Construction Manager why the Work is not to be corrected immediately and when corrective action will be completed.

B. Work performed that is connected or adjacent to Defective Work or Work that would have to be removed to correct Defective Work is also considered to be Defective. Contractor is responsible for all costs associated with replacing any acceptable Work that must be removed, or might be damaged by corrective actions.

C. Document Defective Work, corrective actions taken to correct defects and that corrected Work complies with the Contract Documents.

D. Implement countermeasures to prevent future Defective Work.

E. No payment will be made for Defective Work. Remove Work from the Application for Payment if Work paid for on a previous Application for Payment is found to be Defective.

F. Owner will withhold payment for Defective Work or Work that has not been tested or inspected in accordance with the CQCP, OQCP, or the Contract Documents.

3.03 VERIFICATION TESTING FOR CORRECTED DEFECTS

A. Provide verification testing on corrected Work when corrective action is complete to demonstrate that the corrected Work complies with the Contract Documents. Conduct the same tests or inspections used to determine that the original Work was Defective. Different tests or methods may be used if approved by the OPT. Document that Defective Work has been corrected with the Construction Manager.

B. Pay for verification testing until Work meets quality requirement set forth in the Contract Documents. OPT may perform verification testing as part of its Quality Management Program and impose a Set-off to recover the cost for this testing.

3.04 OWNER'S PRELIMINARY QUALITY CONTROL PLAN

Spec. Section	Test / Frequency	OPT or Contractor
03 30 00	Compressive strength. One set of three cylinders for each concrete placement with one additional set of cylinders for each 50 yards in a single placement.	OPT
33 31 13.13	Hydrostatic Leak Test, Joint Test, and Deflection Test	Contractor
33 05 39	Hydrostatic Leak Test	Contractor
33 39 13	Manhole Testing	Contractor
44 42 56.04	Factory witness testing	OPT

END OF SECTION

01 40 01 IBC SPECIAL INSPECTIONS

PART 1 - GENERAL

1.01 OVERVIEW

A. The purpose of this Section is to provide the Owner and the Contractor with an understanding of what constitutes special inspections as defined by the International Building Code (IBC), Chapter 17, "Special Inspections and Tests," and the Contractor's requirements per IBC and role in enabling the Owner to perform the inspections, and provide the Owner with a Statement of Special Inspection specific to this Project's Special Inspection requirements.

B. IBC Special Inspections are not a substitute for other testing required elsewhere in the Contract Documents.

C. IBC Special Inspections may not be performed by the Contractor, unless the Contractor and Owner are the same entity.

1.02 CONTRACTOR RESPONSIBILITIES

A. Enable the Owner's Project Team (OPT) to conduct the required IBC Special Inspections as outlined below in "Special Inspection Activities by the Owner."

1. Set up pre-construction meeting and coordinate with OPT, prior to beginning construction, regarding the specific inspection needs and requirements that will be performed as part of these Special Inspections.

2. Provide complete access to the Site and make Contract Documents available at the Site.

a. Provide and pay for all means necessary to enable inspection access at each location requiring inspection. This includes ladders, scaffolding, trench boxes/shielding, fall protection, adequate lighting, adequate ventilation, and designated area(s) for storing inspector equipment and test Samples. All required access must be in accordance with OSHA.

b. Protect Special Inspection test specimens of products and construction materials at the Site in accordance with recognized test procedures.

c. Provide sample materials needed to perform tests.

3. Notify the Construction Manager a minimum of 2 working days in advance of when construction activities requiring testing will be performed or when construction activities will limit and/or prevent inspector(s) from observing construction Work already performed.

a. Provide adequate notice before proceeding with Work that would interfere with sampling, testing, or other required verification.

b. Notify the Construction Manager prior to the time that sampling or testing is required. Lead time is to be adequate to allow arrangements to be made for testing.

c. Do not proceed with any Work until tests indicate that the Work is acceptable.

d. Notify the Construction Manager when schedules change as soon as a delay is expected.

4. Provide adequate quantities of representative product to be tested to the laboratory at the designated location.

B. Submit the following documentation as Product Data in accordance with Section 01 31 13 "Project Coordination":

1. A schedule that establishes the approximate major and/or critical inspection Milestones. Provide a revised schedule for alterations to the schedule.

2. Contractor's test and inspection log described in Paragraph 3.01 at Substantial Completion.

C. Special Inspection activities are for the purpose of monitoring the results of the Contractor's Work to see that it is in compliance with the requirements of the Contract Documents.

D. Special Inspection testing requirements mentioned in this Section do not release the Contractor from providing Contractor required testing specified elsewhere in the Contract Documents.

1. Provide all testing documentation required by the Contract Documents.

2. Pay for testing performed to verify Work performed to cure Defective Work complies with the Contract Documents.

E. Special Inspection activities or non-performance of Special Inspection activities do not:

1. Relieve the Contractor of its responsibility to perform Work and furnish materials and products and constructed Work conforming to the requirements of the Contract Documents.

2. Relieve the Contractor of its responsibility for providing adequate quality control measures.

3. Relieve the Contractor of its responsibility for damage to or loss of the material, product, or Work before Owner's acceptance.

4. Constitute or imply Owner's acceptance.

5. Affect the continuing rights of the Owner after Owner's acceptance of the completed Work.

F. All materials and products are subject to Owner's verification testing. Material or products which have been tested or observed by Owner at a supply source or staging area may be re-observed or re-tested by Owner at any time and rejected if they do not comply with the Contract Documents.

1.03 SPECIAL INSPECTION ACTIVITIES BY THE OWNER

A. OPT will provide registered design professionals for special inspection to meet the requirements of 2015 IBC Chapter 17, Structural Tests and Special Inspections, adopted by the City of Beaumont, Texas. The registered design professional in responsible charge (RDPIRC) will coordinate and provide IBC special inspections during construction on the types of work listed below. Additionally, the OPT will employee one or more approved

agencies to perform inspections and tests during construction on the types of work listed in the Statement of Special Inspection.

B. The OPT will perform the following:

1. Permit: As required by the Building Official for permit issuance, submit the Statement of Special Inspection shown in Attachment A.

2. Preconstruction: Submit names and qualifications of each individual inspector scheduled to perform these inspections to the Building Official prior to the start of construction. Minimum requirements for inspectors must be as indicated in the Statement of Special Inspection.

3. Inspections: The RDPIRC will forward a copy of all inspection and test reports to the Building Official. Discrepancies must be brought to the immediate attention of the Contractor and Construction Manager.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION REGISTER

A. Contractor Test and Inspection Register: Include the following:

1. Date Owner was notified of impending construction Work that requires testing and/or that would interfere with subsequent inspections.

2. Name of person notified and the means of notification.

3. Date construction Work in question was completed.

4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain an up-to-date copy of the Contractor Test and Inspection Register at the Site and with Record Documents. Post changes and revisions as they occur. Provide access to the Contractor Test and Inspection Register for RDPIRC, OPT, and AHJ reference during normal working hours.

3.02 REPAIR AND PROTECTION

A. General:

1. On completion of inspections and tests, repair damaged construction and restore substrates and finishes.

2. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration in adjoining areas with durable seams that are invisible as possible.

B. Protect construction exposed by or for special inspection activities.

END OF SECTION

ATTACHMENT A

STRUCTURAL STATEMENT OF SPECIAL INSPECTIONS

This Statement of Special Inspections has been prepared in accordance with the 2015 International Building Code, Chapter 17, by the Structural Engineer of Record for the following Project:

Project Name: _____

Location: _____

Owner: _____

Structural Engineer of Record: _____

Design Professional in Responsible Charge: _____

Special Inspector for _____ : _____

Special Inspector for _____ : _____

Special Inspector for _____ : _____

Abbreviations

Inspectors

AWS-CWI: An American Welding Society/American Institute of Steel Construction certified welding inspector.
AWS/AISC-SSI: An American Welding Society certified structural steel inspector.
ACI: An American Concrete Institute certified technician, certified in the applicable construction type.
EIT: An Engineer-In-Training, a graduate engineer who has passed the Fundamentals of Engineering exam, and is under the direct supervision of a PE.
NICET: A National Institute for Certification in Engineering Technologies certified technician, certified in the applicable construction type.
PE: A licensed professional engineer and/or a structural engineer (SE) competent in the area of construction being inspected.

Specifications

ACI 318: American Concrete Institute Building Code Requirements for Structural Concrete.
ACI 350: American Concrete Institute Code Requirements for Environmental Engineering Concrete Structures.
AISC 360: American Institute of Steel Construction, Specification for Structural Steel Buildings.
ASTM: ASTM International (American Society for Testing and Materials).
AWS: American Welding Society
RCSC: RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

Common Words

C: Continuous observation of specified construction activity.
P: Periodic observation of specified construction activity.
CFSF: Cold formed steel framing.
CD: Contract Documents and/or Shop Drawings (if item is performance specified).

Special Inspector Qualifications

Special Inspectors minimum qualifications are listed below for each area of competency.

Applicable IBC Section	Minimum Inspector Qualifications	Remarks
1704.2.5 & 1705.10 Fabricated Items	N/A	Inspection of a fabrication facility is not required if the fabricator is exempt per IBC. Exemption typically requires a manufacturer be certified by an independent organization (e.g. AISC, IAS, SJI, or NPCA).
1705.2 Steel Construction	AWS-CWI AWS/AISC-SSI, PE, or EIT	All welds must be inspected by an AWS-CWI.
1705.3 Concrete Construction	ACI or NICET, PE, or EIT AWS-CWI	All welds must be inspected by an AWS-CWI.
1705.3 Post-Installed Concrete Anchors	PE	Professional engineer performing inspection must have knowledge of post-installed anchor installation requirements and experience in the design and specifying post-installed anchors.
1705.4 Masonry Construction	ACI or NICET, PE, or EIT AWS-CWI	All welds must be inspected by an AWS-CWI.
1705.5 Wood Construction	Inspector, PE, or EIT	Inspector must have a minimum of 5 years of related experience.
1705.6 Soils	ACI, NICET, PE, or EIT	
1705.7 Driven Deep Foundations	NICET, PE, or EIT	
1705.8 Cast-in-Place Deep Foundations	NICET, PE, or EIT	
1705.9 Helical Pile Foundations	NICET, PE, or EIT	

Concrete Construction

The inspection requirements for this type of construction include cast-in-place concrete.

Verification and Inspection	Frequency		Remarks
	C	P	
Formwork	-	X	Verify formwork for shape, location and dimensions of the concrete member being formed are in conformance with CD.
Reinforcing Steel Material and Type	-	X	Verify size of bars and/or stressing strands, ASTM standard, and grade are in conformance with CD.
Reinforcing Steel Position	-	X	Verify quantity and spacing of bars and/or stressing strands, concrete clear cover on all sides. Verify lap splice type, location, and size. Verify no welding of reinforcing except where specifically noted.
Welding of Reinforcing Steel	X	-	Welding of reinforcing steel is not permitted,
Cast-In-Place Anchors	-	X	Verify size, type, position, and embedment prior to concrete placement. Verify position after concrete placement.
Cast-In-Place Anchors	X	-	Verify placement and consolidation of concrete around anchors.
Mix Design	-	X	Verify batch plant tickets' mix number matches approved mix design for each mix design and application.
Fresh Concrete Samples	X	-	At the same time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete. Sample per ASTM C31, C143, C231 (or C173), C1064. Refer to Section 03 33 00 "Cast-In-Place Concrete"
Placement Technique	X	-	At the time of concrete or shotcrete placement, verify that proper application techniques are being implemented per the CD and ACI 301.
Curing Technique	-	X	Verify that approved means of curing and extreme weather protection are implemented in accordance with the CD.
Prestressed Concrete	X	-	Verify in-situ concrete strength prior to stressing. Refer to CD requirements. Verify application of prestressing forces. Observe grouting of bonded tendons.
Shore Removal	-	X	Verify in-situ concrete strength prior to stressing. Refer to CD requirements.
Fabrication of Precast Members	-	X	If fabricator is audited by an independent agency for each of the items above, then no manufacturer plant verification is required for precast members. If fabricator is not exempt, then review fabrication operations and quality control procedures, and for each product in accordance with the inspection items noted above.

Verification and Inspection	Frequency		Remarks
	C	P	
Erection of Precast Members	-	X	Verify conformance with the CD including welded connections, grouting, and bolting. Where welded connections are specified, verify personnel, equipment, materials, and welds per AWS D1.1. Provide 100% visual inspection of all welds.

Post-Installed Concrete Anchors

The inspection requirements for this type of construction include adhesive and expansion type anchors installed in hardened concrete and masonry construction.

For each construction personnel, anchor type, diameter, and embedment the inspection of initial anchors placed must be continuous based on the requirements below. With the exception of anchors that are upwardly inclined, continuously load in tension, after initial anchor placement inspections have been performed, then inspector may perform quality assurance on a periodic basis.

Any change in personnel or anchor type must require an initial continuous inspection as indicated here.

Verification and Inspection	Frequency		Remarks
	C	P	
Inspection Tasks Prior to Anchor Hole Drilling	-	X	Verify all personnel are qualified to install anchors. Installation of adhesive anchors horizontally or upwardly inclined must be performed by personnel certified by an acceptable program.
	-	X	Verify Contractor has manufacturer's printed installation instructions (MPII) on-site and available for reference by construction personnel.
	-	X	If manufacturer does not have a representative on-site, then special inspector must review MPII with Contractor personnel prior to beginning construction.
	-	X	Verify edge distance limitations indicated in CD's and existing reinforcing locations compared to proposed anchor hole locations.
	-	X	Verify drill bit diameter matches MPII for anchor diameter indicated in CD's. Special inspector does not need to be present during actual drilling of holes.
Inspection Tasks After Drilling Prior to Anchor Placement	-	X	Verify every hole diameter is in accordance with MPII and verify embedment is in accordance with CD's and hole depth is in accordance with MPII (hole depth may need to exceed embedment depth, refer to MPII).
	-	X	Verify cleaning operations are in accordance with CD's and MPII.
	-	X	Verify anchor type, material, diameter, and length.
	-	X	Where adhesive anchors are specified: verify adhesive type is per CD's, adhesive expiration date, and adhesive dispensing equipment is per MPII.

Verification and Inspection	Frequency		Remarks
	C	P	
	-	X	Verify that for horizontal and upwardly inclined adhesive anchors have all MPII required installation items (e.g. piston-plug)
Inspection Tasks During Anchor Placement	-	X	Verify that all anchors are installed in accordance with MPII.

Soils

The inspection requirements for this type of construction include structural fill and compacted fill, and slabs-on-grade.

Verification and Inspection	Frequency		Remarks
	C	P	
Subgrade for Shallow Footings	-	X	Verify that materials below shallow foundations are adequate to achieve the design bearing capacity, excavations are extended to the proper depth, and have reached the proper material.
Backfill Materials	-	X	Perform classification and testing of compacted fill materials. Test per ASTM D422, D1140, and D698 as required to verify fill materials are in accordance with the CD.
Subgrade Preparation	-	X	Verify the use of proper subgrade preparation per the CD, including but not limited to proof rolling and scarifying.
Compaction	X	-	Verify proper fill materials, densities, and lift thicknesses during placement and compaction of fill is in accordance with the CD. Test density of each lift per ASTM D698.

END OF ATTACHMENT A

01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide temporary facilities, including 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

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 galvanized or stainless steel bolts, brackets, fasteners, and other hardware.

D. Provide exterior quality coatings.

2.02 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.

2.03 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.

2.04 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities at the Site for the entire duration of the Project. Maintain these facilities in a clean and sanitary condition at all times, 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.

2.05 TEMPORARY HEAT

A. Provide heating devices needed to protect buildings during construction. Provide fuel needed to operate the heating devices and attend the heating devices at all times they are in operation, including overnight operations.

2.06 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.

a. Use existing power systems where spare capacity is available. Provide temporary power connections that do not adversely affect the existing power supply. Submit connections to the Construction Manager for approval prior to installation.

b. 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 Owner.

3. Provide telephone service to the Site and install telephones inside the Contractor's field office.

B. Provide power for construction and storage. Provide power to energize space heaters for stored electrical equipment.

2.07 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 CONSTRUCTION FENCE

A. Install and maintain a chain-link construction fence around the Site and off-site storage yards. Fence must be a minimum 6 feet high. Provide gates with padlocks.

3.06 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.

3.07 MAINTENANCE AND JANITORIAL SERVICE

A. Maintain signs and supports in a neat, clean condition. Repair damage to structures, framings, or signs.

B. Repair any damage to Work caused by placement or removal of temporary signage.

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.

3. Provide documentation to the Owner which states the nature and strength of the contaminant, method of disposal, and the location of the disposal site.

4. 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 57 23 TEMPORARY STORMWATER POLLUTION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish labor, materials, equipment, and incidentals necessary to provide stormwater pollution prevention for the duration of the construction period including furnishing, installing, and maintaining erosion and sediment control structures and procedures and properly removing the features when no longer required.

B. Develop, implement, and maintain a stormwater pollution prevention plan (SWPPP) in compliance with local, state, and federal Laws and Regulations. Provide preventive measures to keep sediment and other pollutants from the construction activity from entering any stormwater system, including open channels.

C. Comply with the Texas Commission on Environmental Quality General Permit, TXR150000, (General Permit) for storm water discharges from construction activities under the Texas Pollutant Discharge Elimination System (TPDES) program.

D. File all required legal notices and obtain required permits prior to beginning any construction activity.

E. This Section provides guidelines and Best Management Practices information for the Contractor to use in adhering to all local, state, and federal environmental Laws and Regulations with respect to stormwater pollution prevention during construction activities.

1.02 DOCUMENTATION

A. Documentation must be provided in accordance with Section 01 33 00 “Document Management.”

B. Submit copies of required notices and reports to the Construction Manager as Product Data in accordance with Section 01 33 03 “Product Data.” Retain copies of these documents at the Site for review and inspection by the OPT or regulatory agencies at all times.

C. Submit copies of required notices to local, state, and federal authorities and any other entity as required by the General Permit and applicable Laws and Regulations.

D. Post a copy of required notices at the Site in a location where it is readily available for viewing by the general public and local, state, and federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.

E. Maintain copies of a schedule of major construction activities, inspection reports, and revision documentation with the SWPPP required under the General Permit.

F. Provide schedules in accordance with Paragraph 3.05.

1.03 QUALITY ASSURANCE

A. Comply with applicable requirements of all governing authorities having jurisdiction. The Specifications and the Drawings are not intended to be prescriptive but rather to convey

the intent to provide complete slope protection, erosion control, and stormwater pollution prevention for both the Owner's property and adjacent properties.

B. Perform Work to comply with “Best Practices” as established by the local agency of jurisdiction.

C. Contractor must develop and implement a SWPPP in accordance with the General Permit prior to the beginning of construction activity.

D. Contractor assumes solely responsible for implementing, updating, and modifying the General Permit per Laws and Regulations for the SWPPP and Best Management Practices.

E. Stormwater pollution prevention measures must be established prior to the beginning of construction and maintained during the entire length of construction until final stabilization has been achieved for the area protected.

F. All land-disturbing activities must be planned and conducted to minimize the area to be exposed at any one time as well as time of exposure, off-site erosion, sedimentation, and adverse water quality impacts.

G. Surface water runoff originating upgrade of an exposed area must be managed to minimize erosion and sediment loss during the period of exposure.

H. Install measures to control both the velocity and rate of release so as to minimize erosion and sedimentation of the receiving water body (i.e. , ditch, channel, stream) in accordance with regulatory requirements and as directed by the OPT.

I. Periodically clean out and dispose of all sediment and other pollutants as necessary to maintain adequate treatment capacity of each pollution control feature. Clean out and properly dispose of all sediment and other stormwater pollutants at the time of completion of the Work.

1.04 JOB CONDITIONS, CODES AND ORDINANCES

A. Comply with the local codes and ordinances. If local codes and ordinances require more stringent or additional stormwater pollution prevention measures during construction beyond those required by state and federal Laws and Regulations, the Contractor must provide such measures at no additional cost.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials used for stormwater pollution prevention must meet the minimum design and specification requirements identified below for commonly used sediment loss prevention. The Contractor must use appropriate control devices to protect against stormwater pollution from construction site activities.

B. Silt fences for perimeter controls located downstream of disturbed areas are subject to the following design criteria:

1. If 50 percent or less soil by weight passes the U.S. Standard sieve No. 200, select the apparent opening size (A.O.S.) to retain 85 percent of the soil.

2. If 85 percent or more of soil by weight passes the U.S. Standard sieve No. 200, silt fences must not be used unless the soil mass is evaluated and deemed suitable by a soil scientist or geotechnical engineer concerning the erodibility of the soil mass, dispersive characteristics, and the potential grain-size characteristics of the material that is likely to be eroded.

3. Silt fence fabric must meet the following minimum criteria:

    a. Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 90 pounds.

    b. Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 60 pounds.

    c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 280 psi.

    d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 70 (max) to No. 100 (min).

    e. Ultraviolet Resistance, ASTM D4355. Minimum 70 percent.

4. Filter stone for an overflow structure must be 1-1/2-inch washed stone containing no fine material. Angular shaped stone is preferable to rounded shaped stone.

5. Fence posts must be galvanized steel or equivalent and may be T-section or L-section, 1.3 pounds per linear foot minimum, and 4 feet in length minimum. Wood posts may be used depending on anticipated length of service and provided they are 4 feet in length minimum and have a nominal cross-section of 2 inches by 4 inches for pine or 2 inches by 2 inches for hardwoods.

6. Silt fence must be supported by galvanized steel wire fence fabric as follows:

    a. 4-inch by 4-inch mesh size, W1.4/1.4, minimum 14-gauge wire fence fabric;

    b. Hog wire, 12-gauge wire, small openings installed at bottom of silt fence;

    c. Standard 2-inch by 2-inch chain link fence fabric; or

    d. Other welded or woven steel fabrics consisting of equal or smaller spacing as that listed herein and appropriate gauge wire to provide support.

C. Inlet protection used in new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following design criteria:

1. Filter fabric protection must be designed and maintained in a manner similar to a silt fence.

2. Where applicable, filter fabric, posts, and wire backing must meet the material requirements specified herein.

3. Filter gravel must be 3/4-inch washed stone containing no fines. Angular shaped stone is preferable to rounded shapes.

4. Concrete blocks must be standard 8-inch by 8-inch by 16-inch concrete masonry units.

5. When organic filter tubes are used, the designer must specify the type of material to be used (or excluded) on a particular site:

    a. Straw filter material must be Certified Weed Free Forage. The straw must be in good condition, air-dried, and not rotten or moldy.

    b. Wood chips must be 100 percent untreated chips and free of inorganic debris, such as plastic, glass, metal, etc. Wood chip size must not be smaller than 1 inch and must not exceed 3 inches in diameter. Shavings must not be more than 5 percent of the total mass.

6. Bags used to secure inlet protection devices on pavement must be filled with aggregate, filter stone, or crushed rock that is less likely than sand to be washed into an inlet if the bag is broken. Filled bags must be 24 to 30 inches long, 16 to 18 inches wide, and 6 to 8 inches thick. Bags must be polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard and meet the following criteria:

    a. Greater than 300 psi Mullen Burst Strength using ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.

    b. Greater than 70 percent UV Stability using ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus.

D. Stone outlet sediment traps (bermed or excavated) used in situations where flows are concentrated in a drainage swale or channel are subject to the following design criteria:

1. The embankment must be placed on geotextile fabric meeting the following minimum criteria:

    a. Tensile Strength, ASTM D4632 Text Method for Grab Breaking Load and Elongation of Geotextiles, 250 pounds.

    b. Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 135 pounds.

    c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 420 psi.

    d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 20 (max).

2. Fill placed to constrict the swale for construction of the excavated stone outlet sediment trap and fill placed for the berm in the bermed stone outlet sediment trap must consist of clay material, minimum Plasticity Index of 30, using ASTM D4318 Standard Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

3. The embankment must be comprised of well graded stone riprap with a size range of 6 to 12 inches in diameter.

E. Sediment basins used as treatment devices for sites with disturbed areas of 10 acres and larger that are part of a common drainage area are subject to the following design criteria:

1. The embankment must be constructed with clay soil, minimum Plasticity Index of 30 using ASTM D4318 Standard Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

2. Texas Administrative Code Title 30, Chapter 299 (30 TAC 299), Dams and Reservoirs, contains specific requirements for dams that:

    a. Have a height greater than or equal to 25 feet and a maximum storage capacity greater than or equal to 15 acre-feet;

    b. Have a height greater than 6 feet and a maximum storage capacity greater than or equal to 50 acre feet;

    c. Are a high- or significant-hazard dam as defined in Chapter 299, regardless of height or maximum storage capacity; or

    d. Are used as a pumped storage or terminal storage facility.

F. Check dams used for long drainage swales or ditches to reduce erosive velocities are subject to the following design criteria:

1. Use geotextile filter fabric under check dams exceeding 12 inches in height. The fabric must meet the material specified for the Stone Outlet Sediment Trap discussed above.

2. Loose, unconfined soil, wood chips, compost, and other material that can float or be transported by runoff must not be used to construct check dams.

3. Sand bags must not be used for check dams, due to their propensity to break and release sand that is transported by the concentrated flow in the drainage swale or ditch.

4. Rock Check Dams:

    a. Stone must be well graded with stone size ranging from 3 to 6 inches in diameter for a check dam height of 24 inches or less.

    b. The stone size range for check dams greater than 24 inches is 4 to 8 inches in diameter.

5. Rock Bag Check Dams Bags:

    a. Fill material should be pea gravel, filter stone or aggregate that is clean and free of deleterious material.

    b. Bag material must comply with the requirements of Inlet Protection above.

6. Sack Gabion Check Dams:

    a. Sack gabions must be wrapped in galvanized steel, woven wire mesh. The wire must be 20 gauge with 1-inch diameter, hexagonal openings.

    b. Stone must be well graded with a minimum size range from 3 to 6 inches in diameter.

7. Organic Filter Tube Check Dams:

    a. Filter material used within tubes to construct check dams must be limited to coir, straw, aspen fiber and other organic material with high cellulose content.

    b. The material should be slow to decay or leach nutrients in standing water and comply with the requirements for Inlet Protection above.

G. Stabilized construction exits used for sites in which significant truck traffic occurs on a daily basis are subject to the following design criteria:

1. The construction exit material must be a minimum thickness of 6 inches. The stone or recycled concrete used must be 3 to 5 inches in size with little or no fines.

2. The geotextile fabric must meet the following minimum criteria:

    a. Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 300 pounds.

    b. Puncture Strength, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 120 pounds.

    c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 600 psi.

    d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 40 (max).

H. Alternative pollution prevention measures selected by the Contractor must be identified from one or more of the following reference sources, as appropriate for the region of the construction activity:

1. City of Austin Environmental Criteria Manual.

2. North Central Texas Council of Governments (NCTCOG) integrated Stormwater Management (iSWM) Design Manual for Construction.

3. Harris County/Harris County Flood Control District/City of Houston Stormwater Management Handbook for Construction Activities.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prepare a SWPPP in accordance with applicable permit requirements for construction activity. Develop the SWPPP in conformance with the General Permit and any applicable local requirements.

B. Prepare and implement the SWPPP prior to the beginning of construction activity in accordance with local, state, and federal Laws and Regulations.

C. OPT may require Contractor to install stormwater pollution prevention devices and/or practices during construction in addition to those required under the approved SWPPP. Contractor must remain solely responsible for complying with all local, state, and federal Laws and Regulations.

3.02 INSTALLATION

A. Erosion control blankets to hold seed and soil in place until vegetation is established on disturbed areas are subject to the following installation criteria:

1. Prior to the installation of any erosion control matting, all rocks, dirt clods, stumps, roots, trash, and any other obstructions that would prevent the mat from lying in direct contact with the soil must be removed.

2. Anchor trenching must be located along the entire perimeter of the installation area, except for small areas with less than 2 percent slope.

3. Installation and anchoring must conform to the recommendations shown within the manufacturer's published literature for the erosion control blanket.

4. Anchors (staples) must be a minimum of 6 inches in length and 1 inch wide. They must be made of 11-gauge wire, or equivalent, unless the ECB is intended to remain in place with final stabilization and biodegrade.

5. Particular attention must be paid to joints and overlapping material. Overlap along the sides and at the ends of ECBs should be per the manufacturer’s recommendations for site conditions and the type of ECB being installed. At a minimum, the end of each roll of ECB must overlap the next roll by 3 feet and the sides of rolls must overlap 4 inches.

6. After installation, check blankets for uniform contact with the soil, security of the lap joints, and flushness of the staples with the ground.

B. Silt fences for perimeter controls located downstream of disturbed areas are subject to the following installation criteria:

1. Construct fences along a line of constant elevation (along a contour line if possible).

2. Maximum drainage area must be 0.25 acres per 100 linear feet of silt fence.

3. Maximum flow to any 20-foot section of silt fence must be 1 cfs.

4. Maximum distance of flow to silt fence must be 200 feet or less. If the slope exceeds 10 percent, the flow distance must be less than 50 feet.

5. Maximum slope adjacent to the fence must be 2:1.

6. Stone overflow structures or other outlet control devices must be installed at all low points along the fence or spaced at approximately 300 feet if there is no apparent low point.

7. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel to prevent bypass of runoff under the fence. Fabric must overlap at abutting ends a minimum of 3 feet and must be joined such that no leakage or bypass occurs. If soil conditions prevent a minimum toe-in depth of 6 inches or installation of support post to depth of 12 inches, silt fences must not be used.

8. Sufficient room for the operation of sediment removal equipment must be provided between the silt fence and other obstructions in order to properly maintain the fence.

9. The last 10 feet (or more) at the ends of a line of silt fence must be turned upslope to prevent bypass of stormwater. Additional upslope runs of silt fence may be needed

every 200 to 400 linear feet, depending on the traverse slope along the line of silt fence.

C. Inlet protection for new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following installation criteria:

1. 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), when installing inlet protection on publicly traveled streets or in developed areas. Ensure that inlet protection is properly designed, installed, and maintained to avoid flooding of the roadway or adjacent properties and structures.

2. Maximum depth of flow must be 8 inches or less.

3. A 2-inch overflow gap or weir is required on all curb inlet protection devices.

4. Positive drainage is critical in the design of inlet protection. If overflow is not provided for at the inlet, excess flows must be routed through established swales, streets, or other watercourses to minimize damage due to flooding.

5. Filter Fabric Protection:

   a. Filter fabric protection is appropriate where the drainage area is less than 1 acre and the basin slope is less than 5 percent.

   b. Filter fabric, posts, and wire mesh must meet the material requirements specified herein.

   c. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel. This entrenchment prevents any bypass of runoff under the fence.

   d. Stone overflow structures must be installed where flow to the inlet is concentrated and more than 1 cfs according to the criteria in Paragraph 2.01.

6. Block and Gravel Protection (Curb and Drop Inlets):

   a. Concrete blocks are to be placed on their sides in a single row around the perimeter of the inlet, with ends abutting.

   b. Openings in the blocks should face outward, not upward. 1/2-inch by 1/2-inch wire mesh must then be placed over the outside face of the blocks covering the holes.

   c. Filter stone must then be piled against the wire mesh to the top of the blocks with the base of the stone being a minimum of 18 inches from the blocks.

   d. Alternatively, where loose stone is a concern (streets, etc.), the filter stone may be placed in appropriately sized geotextile fabric bags.

7. Excavated Impoundment Protection:

   a. Excavated impoundment protection is only applicable to drop inlets.

   b. It should not be applied to Y inlets because it will undermine the concrete pad surrounding the inlet opening. Nor can it be used for inlets on pavement.

c. With this protection method, it is necessary to install weep holes to allow the impoundment to drain completely.

d. The impoundment must be sized such that the volume of excavation is equal to or exceeds the runoff volume from the temporary control design storm (2-year, 24-hour) for the inlet's drainage area.

e. The trap must have a minimum depth of 1 foot and a maximum depth of 2 feet as measured from the top of the inlet and must have side slopes of 2:1 or flatter.

8. Organic Filter Tube Protection (Curb and Drop Inlets):

a. Organic filter tubes may be used on paved or unpaved surfaces. On paved surfaces, tubes must be secured in place by rock bags. On unpaved surfaces, the tubes must be embedded in the ground a minimum of 3 inches and staked at 4-foot spacing.

b. Designer must provide calculations and specify the diameter of tube to be used based on the inlet's drainage area and the flow rate of runoff to the inlet.

c. The minimum allowable diameter is 12 inches.

d. For curb protection, the diameter of the tube must be at least 2 inches less than the height of the inlet opening. The tube should not be allowed to block the entire opening, since it will clog.

e. The tube must be placed on 4-inch by 4-inch or 2-inch by 4-inch wire mesh to prevent the tube from sagging into the inlet. The tube should be long enough to extend a minimum of 12 inches past the curb opening on each side of the inlet.

D. Stone outlet sediment traps (excavated or bermed) for situations where flows are concentrated in a drainage swale or channel are subject to the following installation criteria:

1. The maximum drainage area contributing to the trap must be less than 10 acres for the excavated trap, and 5 acres or less for the bermed trap. For larger drainage areas a sediment basin must be used.

2. The minimum storage volume must be the volume of runoff from the temporary control design storm (2-year, 24-hour) for the sediment trap's drainage area.

3. The surface area of the design storage must be 1 percent of the area draining to the device.

4. The maximum embankment height must be 6 feet as measured from the toe of the slope on the downstream side.

5. Minimum width of the embankment at the top must be 2 feet.

6. Embankment slope must be 1:5:1 or flatter.

7. The embankment must have a depressed area to serve as the outlet with a minimum width of 4 feet.

8. A 6-inch minimum thickness layer of 1-1/2-inch filter stone must be placed on the upstream face of the embankment when stormwater runoff contains fine silt and clay particles.

9. The embankment must consist of stone riprap or a combination of compacted fill with stone riprap. The stone may be enclosed in wire mesh or a gabion basket and anchored to the channel bottom to prevent washing away.
10. Fill must be placed in 8-inch loose lifts (maximum) and compacted to 95 percent Standard Proctor Density at optimum moisture content using ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
11. Geotextile fabric, covered with a layer of stone, must extend past the base of the embankment on the downstream side a minimum of 2 feet.
12. The outlet must be designed to have a minimum freeboard of 6 inches at design flow.

E. Check dams for long drainage swales or ditches to reduce erosive velocities are subject to the following installation criteria:

1. Typically, the dam height should be between 9 inches and 36 inches, depending on the material of which they are made. The height of the check dam must always be less than one-third the depth of the channel.
2. Dams should be spaced such that the top of the downstream dam is at the same elevation as the toe of the upstream dam. On channel grades flatter than 0.4 percent, check dams should be placed at a distance that allows small pools to form between each check dam.
3. The top of the side of the check dam must be a minimum of 12 inches higher than the middle of the dam. In addition, the side of the dams must be embedded a minimum of 18 inches into the side of the drainage ditch, swale or channel to minimize the potential for flows to erode around the side of the dam.
4. Larger flows (greater than 2-year, 24-hour design storm) must pass the check dam without causing excessive upstream flooding.
5. Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow off-site.
6. Rock Check Dams: Rock check dams must have a minimum top width of 2 feet with side slopes of 2:1 or flatter.
7. Rock Bag Check Dams:
    a. Rock bag check dams should have a minimum top width of 16 inches.
    b. Bag length must be 24 to 30 inches, width must be 16 to 18 inches, and thickness must be 6 to 8 inches and having a minimum weight of 40 pounds.
    c. Minimum rock bag dam height of 12 inches would consist of one row of bags stacked on top of two rows of bag. The dam must always be one more row wide than it is high, stacked pyramid fashion.
    d. PVC pipes may be installed through the dam to allow for controlled flow through the dam. Pipe should be schedule 40 or heavier polyvinyl chloride (PVC) having a nominal internal diameter of 2 inches.

8. Sack Gabion Check Dams:

    a. Sack gabion check dams may be used in channels with a contributing drainage area of 5 acres or less.

    b. Wire mesh must be one piece, wrapped around the rock, and secured to itself on the downstream side using wire ties or hog rings.

    c. Sack gabions must be staked with 3/4-inch rebar at a maximum spacing of 3 feet. Each wire sack must have a minimum of two stakes.

9. Organic Filter Tube Check Dams:

    a. Organic filter tubes may be used as check dams in channels with a contributing drainage area of 5 acres or less.

    b. Organic filter tubes must be a minimum of 12 inches in diameter.

    c. Staking of filter tubes must be at a maximum of 4-foot spacing and must alternate through the tube and on the downstream face of the tube.

F. Stabilized construction exits for sites in which significant truck traffic occurs on a daily basis are subject to the following installation criteria:

1. Limit site access to one route during construction, if possible; two routes for linear and larger projects.

2. Prevent traffic from avoiding or shortcutting the full length of the construction exit by installing barriers. Barriers may consist of silt fence, construction safety fencing, or similar barriers.

3. Design the access point(s) to be at the upslope side of the construction site. Do not place construction access at the lowest point on the construction site.

4. Stabilized Construction Exits are to be constructed such that drainage across the entrance is directed to a controlled, stabilized outlet on-site with provisions for storage, proper filtration, and removal of wash water.

5. The exit must be sloped away from the paved surface so that stormwater is not allowed to leave the Site onto roadways.

6. Minimum width of exit must be 15 feet.

7. Vehicles must not be permitted to track or drop sediment onto paved roads, streets, or parking lots. When necessary, vehicles must be cleaned to remove sediment prior to exit onto paved areas. When washing is required, it must be done on a constructed wheel wash facility that drains into an approved sediment trap or sediment basin or other sedimentation/filtration device.

8. Minimum dimensions for the exit must be as follows:

Tract Area	Min. Width of Exit	Min. Length of Exit
<1 Acre	15 feet	20 feet
≥ 1 acre but <5 Acres	25 feet	50 feet
≥5 Acres	30 feet	50 feet

G. Install pollution control devices in a manner consistent with their designed intent.

3.03 MAINTENANCE

A. Maintain pollution prevention control structures and procedures in full working order at all times during construction. This must include any necessary repair or replacement of items which have become damaged or ineffective. Remove sediment and other pollutants which accumulate in pollution control devices as necessary to maintain the intended design efficiency for the pollution prevention measure.

B. Dispose properly of trash, debris, and other pollutants.

C. Place sediment material in approved earth spoil areas or return the sediment material to the area from which it eroded.

D. Maintain pollution prevention structures and procedures until construction is complete for the area protected and until the Site achieves final stabilization. Unless more stringently defined by local, state, or federal requirements, final stabilization is defined as achieving 70 percent of background vegetative cover or placement of permanent cover, such as concrete or asphalt.

E. Upon completion of construction and achievement of final stabilization, properly remove the temporary pollutant control structures and complete the area as indicated. Pollution control devices made of organic materials designed to degrade naturally in place will not require removal, unless specifically required by the OPT.

F. Erosion control blankets must be inspected regularly (at least as often as required by the General Permit) for bare spots caused by weather related events. Missing or loosened blankets must be replaced or re-anchored. Also check for excess sediment deposited from runoff. Remove sediment and/or replace blanket as necessary. In addition, determine the source of excess sediment and implement appropriate Best Management Practices to control the erosion.

G. Silt fences must be inspected regularly (at least as often as required by the General Permit) for buildup of excess sediment, undercutting, sags, and other failures. Sediment should be removed when it reaches approximately one-half the height of the fence. In addition, determine the source of excess sediment and implement appropriate Best Management Practices to control the erosion. If the fabric becomes damaged or clogged, it must be repaired or replaced as necessary.

H. Inlet protection must be inspected regularly (at least as often as required by the General Permit). Floatable debris and other trash caught by the inlet protection should be removed after each storm event. Sediment should also be removed from curb inlet protection after each storm event because of the limited storage area associated with curb inlets. Sediment collected at inlet protection should be removed before it reaches half the height of the protection device. Sediment should be removed from inlets with excavated impoundment protection before the volume of the excavation is reduced by 50 percent. In addition, the weep holes should be checked and kept clear of blockage. Concrete blocks, 2-inch by 4-inch boards, stakes, and other materials used to construct inlet protection should be checked for damaged and repaired or replaced if damaged. When filter fabric or organic filter tubes are used, they should be cleaned or replaced when the material becomes clogged. For systems using filter stone, when the filter stone becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Because of the potential for inlet protection to divert runoff or cause localized flooding, remove inlet

protection as soon as the drainage area contributing runoff to the inlet is stabilized. Ensure that all inlet protection devices are removed at the end of the construction.

I. The stone outlet sediment trap should be inspected regularly (at least as often as required by the General Permit) to check for clogging of the void spaces between stones. If the filter stone appears to be clogged, such that the basin will not completely drain, then the filter stone will require maintenance. If the filter stone is not completely clogged it may be raked with a garden rake to allow the water to release from the basin. If filter stone is completely clogged with mud and sediment, then the filter stone will have to be removed and replaced. Failure to keep the filter stone material properly maintained will lead to clogging of the stone riprap embankment. When this occurs, the entire stone rip-rap structure will need to be replaced. If the aggregate appears to be silted in such that efficiency is diminished, the stone should be replaced. Trash and debris should be removed from the trap after each storm event to prevent it from plugging the rock. Deposited sediment must be removed before the storage capacity is decreased by one-third, or sediment has reached a depth of 1 foot, whichever is less. The removed sediment must be stockpiled or redistributed in areas that are protected with erosion and sediment controls.

J. Sediment basins should be inspected regularly (at least as often as required by the General Permit) to check for damage and to ensure that obstructions are not diminishing the effectiveness of the structure. Sediment must be removed and the basin must be re-graded to its original dimensions when the sediment storage capacity of the impoundment has been reduced by 20 percent. The removed sediment may be stockpiled or redistributed on-site in areas that are protected by erosion and sediment controls. Inspect temporary stabilization of the embankment and graded basin and the velocity dissipaters at the outlet and spillway for signs of erosion. Repair any eroded areas that are found. Install additional erosion controls if erosion is frequently evident.

K. Check dams should be inspected regularly (at least as often as required by the General Permit). Silt must be removed when it reaches approximately one-third the height of the dam or 12 inches, whichever is less. Inspectors should monitor the edges of the dam where it meets the sides of the drainage ditch, swale, or channel for evidence of erosion due to bypass or high flows. Eroded areas must be repaired. If erosion continues to be a problem, modifications to the check dam or additional controls are needed. Care must be used when taking out rock check dams in order to remove as much rock as possible. Loose rock can create an extreme hazard during mowing operations once the area has been stabilized.

L. Stabilized construction exits should be inspected regularly (at least as often as required by the General Permit). The stabilized construction exit must be maintained in a condition that prevents tracking or flow of sediment onto paved surfaces. Periodic re-grading and top dressing with additional stone must be done to keep the efficiency of the exit from diminishing. The rock must be re-graded when ruts appear. Additional rock must be added when soil is showing through the rock surface. Additional controls are needed if inspections reveal a properly installed and maintained exit, but tracking of soil outside the construction area is still evident. Additional controls may be daily sweeping of all soil spilled, dropped, or tracked onto public rights-of-way or the installation of a wheel cleaning system.

3.04 FIELD QUALITY CONTROL

A. In the event of conflict between the specified requirements and stormwater pollution control laws, rules, or regulations or other local, state, or federal agencies, the more restrictive laws, rules, or regulations will apply.

3.05 SCHEDULES

A. Prior to start of construction, submit schedules to the OPT for accomplishment of temporary and permanent erosion control work in connection with required clearing and grubbing, grading, construction, and paving. Include a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials in the submittal.

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 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 through the PMIS.

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

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 3.01C.

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 SUPPLIER'S REPRESENTATIVE

A. Supplier'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
44 42 56.04	Submersible Pumps	4

END OF SECTION

02 41 00 DEMOLITION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary for every type of required demolition.

B. Furnish equipment of every type required to demolish and transport construction debris away from the Site.

1.02 STANDARDS

A. Work shall be performed in accordance with the codes and ordinances of the agency having jurisdiction over the Place of Record.

1.03 DELIVERY AND STORAGE

A. Stockpile construction debris at the Site only as long as necessary to haul to a disposal site. Stack materials neatly and handle in an orderly manner until removed from the Site.

1.04 JOB CONDITIONS

A. Contractor shall visit the Site and determine the extent of demolition required and the Site conditions that might affect his proposal. Include costs of covering all aspects of the demolition as part of the proposal.

B. The Drawings shall be carefully reviewed to determine the extent of necessary demolition and to identify elements of the existing construction which are to remain in place. Report any discrepancies to Owner and Engineer before disturbing existing conditions. Property lines and limits of demolition shall be accurately located prior to beginning site demolition. Start of demolition activities shall represent confirmation by Contractor that existing conditions are as presented in the Contract Documents. Demolition outside the limits indicated on the Drawings, or outside the property lines shall not be performed.

1. For electrical demolition, verify field measurements and circuiting arrangements are as shown on the Drawings. Verify that existing wiring and equipment serve only abandoned facilities.

C. Material removed during demolition, and any equipment not otherwise designated to remain the property of the Owner, shall become the property of the Contractor and shall be promptly removed from the Site.

D. Equipment and material designated as remaining the property of the Owner shall be removed from the structure and transported to a designated location on the Site and stored for the Owner's use. Store on wood runners raised above the surrounding grade and cover with weather resistant covering that is tied securely in place.

E. Take necessary precautions in removing Owner designated property to prevent damage during the demolition process. Equipment shall be removed in one piece. Loose components may be removed separately. Controls and electrical equipment may be

removed from the equipment and handled separately. Large units, such as motor driven pumps, may be dismantled and motors handled separately. Do not use a cutting torch to separate the Owner's equipment or material. Salvaged piping shall be taken apart at flanges or fittings and removed in sections.

F. The Owner's designated property shall include:

1. Piping as follows:

a. To be coordinated with the City.

2. Other items to be coordinated with the City.

1.05 HAZARDOUS MATERIALS

A. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

2.00 PRODUCTS

2.01 MATERIALS

A. New materials and equipment for patching and extending work shall meet the requirements of the individual Sections in these Contract Documents. For materials not addressed in these documents, materials used shall meet or exceed the dimensions and quality of the existing work.

3.00 EXECUTION

3.01 SITE CLEARING

A. Perform site clearing to the limits indicated on the drawings. Scrape the Site, removing brush, trees, weeds and trash. Haul debris away from the Site as it accumulates.

B. Grub out tree and brush roots within the limits of buildings, parking lots, driveways and other structures. Remove rock out-croppings and boulders from any area within the limits of grading or structures. Remove roots and backfill any excavation resulting from tree removal.

C. Trees not located within the construction limits, or otherwise indicated for removal, shall remain in place. Visit the Site with the Engineer or Owner and identify those trees that are to remain. Mark all other trees with yellow paint to indicate removal. Protect remaining trees during construction. Wrap the tree trunks with 2 x 4 timbers if construction equipment must operate in close proximity to them.

D. Only designated trees shall be removed. In the event that trees other than those designated are erroneously removed, install replacement trees of equal size and number to compensate for those destroyed, at no additional cost to the Owner.

3.02 BUILDING DEMOLITION

A. Demolition shall include any item noted on the Drawings or required to make room for new Work as indicated on the Drawings. Demolition drawings included in the Contract

Documents are provided for the Contractor's reference, but are not intended to limit the demolition to those items shown or otherwise noted. Contractor is responsible to verify for himself any demolition necessary to perform the Work.

B. Remove all partitions indicated on the Drawings or required to complete the new construction. Where partitions are noted to be removed, also remove all electrical devices, conduit and wiring inside the partitions. Where existing partitions have plumbing stacks or domestic water piping inside partitions, also remove all piping and other related components. Remove all plumbing fixtures and related trim, fittings and fixture hangers.

C. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

3.03 REMOVAL OF CONCRETE SLABS

A. Remove parts of the existing concrete floor slab as indicated on the Drawings. Saw-cut the existing slab with two parallel lines around the area to be removed to the depth of the reinforcing. Do not cut reinforcing. Break out the remainder of the slab using jackhammers or by manual means. Cut reinforcing at a distance of 24 inches from the cut edge of the slab and bend back out of the way. Perform the remainder of the demolition, removing underground piping, or installing new Work.

B. After buried Work has been completed, bend the reinforcing bars back into proper place and add new reinforcing of the same size and number as the remaining dowels. Lap the joints a minimum of 18 inches and securely tie in place. Replace concrete as required to repair the slab. Concrete shall be Type A as specified in Section 03 30 00 "Cast-In-Place Concrete."

3.04 REMOVAL OF EXISTING SITE STRUCTURES

A. Remove concrete or masonry structures located below the ground line where indicated or where such structures will interfere with new construction. Where structures are a part of an active underground utility system, repair piping to prevent blockage in the flow.

B. Remove abandoned manholes, basins, or similar structures. With the Engineer's approval, and if structures will not interfere with any other proposed construction, they may be abandoned in place. Remove the top part of the structure so that it is a minimum of 2 feet below the new finish grade. Remove part of the floor system of basins, manholes and other such structures to prevent entrapment of water. Fill remaining cavities with approved backfill material.

3.05 REMOVAL OF PIPE

A. Remove pipe designated for salvage by carefully excavating surrounding backfill material. Remove pipe using protective measures which prevent damage. Piping shall be disconnected at joints, allowing removal in one piece. Salvaged pipe determined unsatisfactory for re-use by the Engineer may be removed in any manner. Suspended or supported pipe shall be disassembled at joints. Remove in sections without cutting. Welded pipe sections may be cut with a torch, but cuts shall be along a welded joint.

3.06 UNDERGROUND PIPING

A. Contractor shall be responsible for obtaining location of underground utilities at the Site. Arrange for all applicable utility companies to accurately locate underground piping and set color-coded flags along the pipe route. Investigate utility company's records to ascertain depths and sizes of piping and other ancillary features.

B. In the event that exact location of piping cannot be obtained, dig test holes as necessary to establish location of piping. Contractor shall not use mechanical digging machines within 6 feet of any active buried piping. For a distance of 4 feet on either side of buried piping, all digging shall be by hand excavation. If the piping is not active, or is to be abandoned or removed, any form of excavation may be used.

3.07 BACKFILLING

A. Backfill cavities resulting from demolition. Fill cavities occurring within the limits of buildings, structures, or pavements in accordance with the requirements of other Sections of the Specifications. Backfill and compact cavities outside the construction limits to the same density as the surrounding earth. No testing is required for backfill outside the limits of new construction.

3.08 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

1. Lights: Use mild detergent to clean all exterior and interior surfaces. Rinse with clean water and wipe dry. Replace lamps and broken electrical parts.

END OF SECTION

02 51 30 ASPHALT PAVING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to perform operations in connection with the construction of hot mix asphaltic concrete (HMAC) base course, leveling-up course and surface course or any other combination of these courses. Construct the pavement on the previously completed and approved subgrade, base, or existing pavement.

1.02 QUALITY ASSURANCE

A. Design Criteria: Use the services of an independent testing laboratory to prepare a mix design to comply with Texas Department of Transportation, Standard Specification Item 340 or may use a previously prepared mix design meeting the specification requirements with satisfactory substantiation of experience with the mix.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01330 “Document Management” and shall include:

1. Mix design as record data.

1.04 STANDARDS

A. Hot mix asphaltic concrete (HMAC) pavement shall conform to the requirements of the current Texas Department of Transportation (TXDOT), Standard Specification for “Dense-Graded Hot Mix Asphaltic “, Item 340.

B. Asphaltic material shall comply with Texas Department of Transportation (TXDOT) Standard Specification Item 300.

1.05 DELIVERY AND STORAGE

A. Haul the asphaltic mixture to the job site in tight vehicles previously cleaned of foreign materials. Arrange the dispatching of vehicles so that all material delivered shall be placed and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers may be required. The inside of the truck body may be given a light coating of oil, if necessary, to prevent the asphaltic mixture from adhering to the body.

1.06 JOB CONDITIONS

A. Do not apply prime coat when the air temperature is below 50 F and falling, but may be applied when the air temperature is above 40 F and rising, the air temperature being taken in the shade and away from artificial heat. Do not place asphaltic material when general weather conditions, in the opinion of the Owner’s Representative are not suitable.

B. The asphaltic mixture shall be at a temperature between 225 and 350 F when dumped from the mixer. The Owner’s Representative shall determine the temperature, within the above

limitations. The mixture when dumped from the mixer shall not vary from the selected temperature more than 30 F.

2.00 PRODUCTS

2.01 MATERIALS

A. Aggregate: Conform to TXDOT Standard Specification Item 340. The Type "B" mixtures and at least three bins when producing Type "D" mixture. These bins shall contain the following sizes of aggregate, in percentages by weight or by volume, as applicable.

1. Gradation for base course or leveling-up course shall comply with Type B listed as follows:

a. Type "B" (Fine Graded Base Course):

Sieve Size	Percent Passing by Weight or Volume
1"	98-100
3/4"	84-98
5/8"	75-95
3/8"	60-80
No. 4	40-60
No. 8	29-43
No. 30	13-28
No. 50	6-20
No. 200	2-7
VMA percent minimum	12
The asphaltic material shall form from 3.5 to 7 percent of the mixture by weight unless specified otherwise on the plans.	

2. Gradation for surface course shall comply with Type D listed as follows:

a. Type "D" (Fine-Graded Surface Course):

Sieve Size	Percent Passing by Weight or Volume
1/2"	98-100
3/8"	85-100
No. 4	50-70
No. 8	35-46
No. 30	15-29
No. 50	7-20
No. 200	2-7

Sieve Size	Percent Passing by Weight or Volume
VMA percent minimum	14
The asphaltic material shall form from 4 to 8 percent of the mixture by weight unless specified otherwise on the plans.	

B. Asphaltic Materials: Comply with TXDOT Standard Specification Item 300. In general, the grade of asphalt shall be AC-10. Other grades of asphalt shall be considered if weather conditions or mix design appear to warrant a change. Prime coat shall comply with TXDOT Standard Specification Item 300, Grade MC-30. Tack coat shall meet the requirements of cutback asphalt RC-250.

2.02 EQUIPMENT

A. The equipment necessary for the construction of the hot mix asphaltic concrete pavement shall be on the project site and shall be approved by the Owner's Representative as to condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used. Equipment shall be maintained in good repair and operating condition.

B. Spreading and Finishing Machines:

1. The spreading and finishing machine shall be of a type approved by the Owner's Representative and capable of producing a surface that shall meet the requirements of the typical cross section and surface test.

2. Rollers:

a. Pneumatic Tire Roller: The roller shall consist of not less than seven pneumatic tire wheels, running on axles in such a manner that the rear group of tires shall cover the entire gap between adjacent tires of forward group; mounted in a rigid frame; and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such a manner that the roller may be turned within a minimum circle. The tire shall afford surface contact pressures up to 90 pounds per square inch or more. The roller shall be so constructed as to operate in both forward and a reverse direction with suitable provisions for moistening the surface of the tires while operating; and shall be approved by the Owner's Representative.

b. Two-Axle Tandem Roller: The roller shall be an acceptable power-driven, steel-wheel tandem roller weighing not less than 8 tons. The roller must operate in forward and reverse directions; contain provisions for moistening the surface of the wheels while in motion; and shall be approved by the Owner's Representative.

c. Three-Wheel Roller: The roller shall be an acceptable power-driven, all steel three wheel roller weighing not less than 10 tons. The roller must operate in forward and reverse directions; contain provisions for moistening the surface of the wheels while in motion; and shall be approved by the Owner's Representative.

d. Vibratory Steel Wheel Roller: If approved for use by the Owner's Representative, this roller shall have a minimum weight of 6 tons. The compactor shall be equipped

with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used. The roller shall be operated in accordance with the Manufacturer's recommendations.

3. Straightedges: The Contractor shall provide acceptable straightedges for the surface testing. Satisfactory templates shall be provided as required by the Owner's Representative.

3.00 EXECUTION

3.01 PREPARATION

A. Prime Coat: Apply a uniform coat of prime coat asphaltic material to the surface of the prepared subgrade, sub-base, or base, applied at a rate of not less than 0.30 gallons per square yard of surface. Apply a thin uniform coat of the prime coat material to contact surfaces of gutters, manholes, and other structures.

B. Tack Coat: Thoroughly clean the surface of the asphalt base course and apply a uniform coat of tack material meeting the requirements for cutback asphalt RC-250. Apply a tack coat when the surface to be paved is Portland cement concrete, brick, or asphaltic pavement. Apply the tack coat using sprayer at a rate not exceeding 0.05 gallons per square yard surface. Paint contact surfaces of curbs, gutters, vertical faces, and other structures in actual contact with asphaltic mixes with asphaltic material to provide a closely bonded, water-tight joint.

C. Compacted Thickness of Asphaltic Concrete Surface Courses and Base Courses:

1. Surface Course: The compacted thickness or depth of the asphaltic concrete surface shall be as indicated on the plans. Where the plans indicate a depth or thickness of the surface course greater than 2 inches compacted depth, same shall be placed in multiple courses of equal depth, each which shall not exceed 2 inches compacted depth. A tack coat is required between any of the multiple courses, and applied at the rate specified.

2. Base Course: The compacted thickness or depth of each base shall be as indicated. Where the plans indicate a depth or thickness of the course greater than 4 inches, same shall be accomplished by constructing multiple lifts of approximately equal depth, each of which shall not exceed these maximum compacted depths. An additional tack coat is required between any of the multiple lifts and must be applied at the rate specified.

3.02 PLACEMENT

A. Place the asphaltic mixture on an approved base course with the previously specified spreading and finishing machine in such a manner that, when properly compacted, the finished course shall comply with the maximum thickness requirements, shall be smooth, of uniform density and meet the requirements of the typical cross-sections and the surface test. During the placing and spreading of the asphaltic material, take care to prevent the spilling of the material onto adjacent pavement, gutters, or structures.

B. In small areas, which are inaccessible to the spreading and finishing machine, hand spreading may be authorized by the Owner's Representative, provided an acceptable surface can be obtained.

3.03 COMPACTION

A. Rolling with the three-wheel and tandem rollers shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Rolling with the pneumatic tire roller shall be done as directed by the Owner's Representative. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic surface material. If displacement should occur, correct the situation at once by the use of rakes and fresh asphaltic mixtures. The roller shall not be allowed to stand on the surface course when it has not been fully compacted and allowed to cool. To prevent adhesion of the surface to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted. Rollers must be in good mechanical condition. Take the necessary precautions to prevent the dripping of gasoline, oil, grease, or other foreign matter on the surface course while the rollers are in motion or when standing. In areas where surface course cannot be compacted with the roller, hand tamps, lightly oiled, shall be used to secure the required compaction.

B. With approval by the Owner's Representative, the vibratory steel wheel roller may be substituted for the three-wheel roller and tandem roller. Each course, after final compaction, shall contain from 5 to 9 percent air voids determined by TXDOT Test Method TEX207-F and TEX-227-F.

3.04 FIELD QUALITY CONTROL

A. Surface Tests: The finished surface of the pavement after compression shall be smooth and true to the established line, grade, and cross-section. When tested with a 16-foot straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of 1/16 inch per foot from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed 1/4 inch at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

B. Pavement Thickness Test: Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the Owner or his authorized representative unless otherwise specified in the special provisions or in the plans. The number and location of tests shall be at the discretion of the Owner's Representative. The cost for the initial pavement thickness test shall be at the expense of the Owner. In the event a deficiency in the thickness of the pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the Contractor's expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.

END OF SECTION

02 51 31 REFERENCE STANDARDS AND SPECIFICATIONS

1.00 GENERAL

1.01 SUMMARY

A. Contractor shall comply with all standards and specifications referenced in this Section.

1.02 CITY OF BEAUMONT TECHNICAL SPECIFICATIONS

City of Beaumont Technical Specifications listed here can be found at the following web address: https://beaumonttexas.gov/wp-content/uploads/pdf/water/water_technical_specifications.pdf

A. Item 600 – Construction of Pipes

B. Item 708 – Manholes

C. Item 712 – Trench Safety Systems

D. Item 02221 – Removing Existing Pavement and Structures

E. Item 02317 – Excavation and Backfill for Utilities

F. Item 02320 – Utility Backfill Material

G. Item 02611 – Reinforced Concrete Pipe

H. Item 03301 – Precast Concrete Manholes

1.03 TXDOT STANDARDS

TxDOT Standards listed here can be found at the following web address: https://www.dot.state.tx.us/DES/specs/2004/itm04ndx.htm

A. Item 161 – Compost

B. Item 420 – Concrete Structures

C. Item 421 – Hydraulic Cement Concrete

D. Item 423 – Retaining Walls

E. Item 432 – Riprap

F. Item 440 – Reinforcement for Concrete

G. Item 445 – Galvanizing

H. Item 458 – Waterproofing Membranes for Structures

I. Item 465 – Junction Boxes, Manholes, and Inlets

J. Item 471 – Frames, Grates, Rings, and Covers

K. Item 500 – Mobilization

L. Item 502 – Barricades, Signs, and Traffic Handling

M. Item 506 – Temporary Erosion, Sedimentation, and Environmental Controls

N. Item 556 – Pipe Underdrains

END OF SECTION

03 11 00 CONCRETE FORMING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish material and labor to form, tie, brace and support wet concrete, reinforcing steel and embedded items until the concrete has developed sufficient strength to remove forms.

1.02 QUALITY ASSURANCE

A. Design Criteria: Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete, the temperature of the concrete, and all other pertinent factors shall be taken into consideration when determining the depth of the equivalent liquid. An additional design live load of 50 pounds per square foot shall be used on horizontal surfaces.

B. Alignment Control: True alignment of walls and other vertical surfaces having straight lines or rectangular shapes shall be controlled and checked by the following procedures:

1. Forming shall be arranged with provisions for adjusting the horizontal alignment of a form, after the form has been filled with concrete to grade, using wedges, turn buckles, or other adjustment methods. Establish a transit line or other reference so that adjustments can be made to an established line while the concrete in the top of the form is still plastic.

2. Adjusting facilities shall be at intervals which permit adjustments to a straight line. Concrete shall not be placed until adequate adjusting facilities are in place.

C. Tolerances: Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Record Data: Manufacturers’ literature for specified products.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Concrete Institute (ACI) Specifications:

ACI 117	Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete

2. American Institute of Steel Construction (AISC) Publication:

a. AISC Manual of Steel Construction.

3. American Iron and Steel Institute (AISI) Publication:
    a. AISI Cold Formed Steel Design Manual.
4. American Plywood Association (APA) Standards:
    a. APA Design/Construction Guide: Concrete Forming.

1.05 DELIVERY AND STORAGE

A. Lumber for forms shall be stacked neatly on platforms raised above ground.

1.06 JOB CONDITIONS

A. The Contractor shall notify the Engineer upon completion of various portions of the work required for placing concrete so that compliance with the plans and specifications may be monitored. The Engineer will authorize the Contractor to proceed with the placement after this has been completed and corrections, if required, have been made.

B. In hot weather, both sides of the face forms may be required to be treated with oil to prevent warping and to secure tight joints.

2.00 PRODUCTS

2.01 MATERIALS

A. Lumber: Properly seasoned and of good quality; free from loose or unsound knots, knot holes, twists, shakes, decay, splits, and other imperfections which would affect its strength or impair the finished surface of the concrete.
    1. Refer to Section 03 30 00 “Cast-In-Place Concrete” for finish requirements.

B. Fiber Board Form Lining: Hardboard finished smooth on one side; minimum thickness of 3/16 inch thoroughly wet with water at least 12 hours before using.

C. Plywood Form Lining: Conforming to APA HDO; exterior exposure waterproof adhesive, 3/8 inch thick.

D. Form Oil: Light, clear oil; shall not discolor or injuriously affect the concrete surface, subsequent coatings, or delay or impair curing operations.

2.02 FABRICATIONS

A. Lumber: Lumber for facing or sheathing shall be surfaced on at least one side and two edges, and sized to uniform thickness. Lumber of nominal 1-inch thickness or plywood of 3/4-inch thickness shall be permitted for general use on structures, if backed by a sufficient number of studs and wales.

B. Special Form Lumber:
    1. Molding for chamfer strips or other uses shall be made of redwood, cypress, or pine materials of a grade that will not split when nailed, and which can be maintained to a true line without warping. The form shall be mill cut and dressed on all faces. Fillet forms at sharp corners, both inside and outside and at edges, with triangular chamfer

strips at all non-contiguous edges exposed to view. Thoroughly oil chamfer strips before installation on forms.

2. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints, and designed so that the finished work shall be true, sharp and clean cut.

C. Forms:

1. Forms shall be built mortar tight and of material sufficient in strength to prevent bulging between supports.

2. Reused forms or form lumber shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and smoothness of surface.

3. All forms shall be so constructed as to permit removal without damage to the concrete. Exercise special care in framing forms for copings, offsets, railing and ornamental work, so that there will be no damage to the concrete when the forms are removed.

D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

E. Metal Forms:

1. The specifications for “Forms” regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, re use, oiling, and wetting shall apply equally to metal forms.

2. The metal used for forms shall be of such thickness that the forms will remain true to shape. Bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete.

3. Metal forms which do not present a smooth surface or line up properly shall not be used. Exercise special care to keep metal free from rust, grease, or other foreign material that discolors the concrete.

F. Form Linings:

1. Timber forms for exposed concrete surfaces which are to be given a rubbed finish shall be face-lined with an approved type of form lining material.

2. If plywood is used for form lining, it shall be made with waterproof adhesive and have a minimum thickness of 3/4 inch. It shall preferably be oiled at the mill and then re-oiled or lacquered on the job before using.

3. If fiber board is used, apply water to the screen side on the board. Stack the boards screen side to screen side. Use the smooth hard face as the contact surface of the form. Such surfaces may be formed with 3/4-inch thick plywood made with waterproof adhesive if backed with adequate studs and wales. The greatest strength of the outer plies should be at right angles to the studding. In this case, form lining will not be required.

4. Carefully align edges and faces of adjacent panels and fill the joints between panels with patching plaster or cold water putty to prevent leakage. Lightly sand with No. 0 sandpaper to make the joints smooth.

5. Forms which are reused shall have all unused form tie holes filled and smoothed as specified above.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties:

1. Metal form ties shall be used to hold forms in place and to provide easy metal removal. The use of wire for ties shall not be permitted.

2. Leave no metal or other material within 1-1/2 inches of the surface, when removing form tie assemblies which are used inside the forms to hold the forms in correct alignment. The assembly shall provide cone-shaped depressions in the concrete surface at least 1 inch in diameter and 1-1/2 inches deep to allow filling and patching. Such devices, when removed, shall leave a smooth depression in the concrete surface without undue injury to the surface from chipping or spalling.

3. Burning off rods, bolts, or ties shall not be permitted.

4. Metal ties shall be held in place by devices attached to wales. Each device shall be capable of developing the strength of the tie.

5. Metal and wooden spreaders which are separate from the forms shall be wired to top of form and shall be entirely removed as the concrete is placed.

6. In the construction of basement or water bearing walls, the portion of a single rod tie that is to remain in the concrete shall be provided with a tightly fitted washer at midpoint to control seepage. Multi-rod ties do not require washers. The use of form ties which are tapered on encased in paper or other material to allow the removal of complete tie, and which leave a hole through the concrete structure, shall not be permitted.

I. Falsework:

1. Falsework shall be designed and constructed so that no excessive settlement or deformation occurs. Falsework shall provide necessary rigidity.

2. Timber used in falsework centering shall be sound, in good condition and free from defects which impair its strength.

3. Steel members shall be of adequate strength and shape for the intended purpose.

4. Timber piling used in falsework may be of any wood species which satisfactorily withstands driving and which adequately supports the superimposed load.

5. When sills or timber grillages are used to support falsework columns, unless founded on solid rock, shale or other hard materials, place them in excavated pits. Backfill to prevent the softening of the supporting material from form drip or from rains that may

occur during the construction process. Sills or grillages shall be of ample size to support the superimposed load without settlement.

6. Falsework not founded on a satisfactory spread footing shall be supported on piling, which shall be driven to a bearing capacity to support the superimposed load without settlement.

3.00 EXECUTION

3.01 PREPARATION

A. Before placing concrete, ensure that embedded items are correctly, firmly and securely fastened into place. Embedded items shall be thoroughly clean and free of oil and other foreign material. Anchor bolts shall be set to the correct location, alignment and elevation by the use of suitable anchor bolt templates.

3.02 INSTALLATION

A. Pre-Placement:

1. During the elapsed time between building the forms and placing the concrete, maintain the forms to eliminate warping and shrinking.
2. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
    a. For concrete surfaces exposed to view: Class A, 1/8 inch.
    b. For concrete surfaces to receive a rubbed finish: Class A, 1/8 inch.
    c. For concrete surfaces to receive plaster, stucco or wainscoting: Class B, 1/4 inch.
    d. For concrete surfaces not exposed to view: Class D, 1 inch.
3. Construct forms tight enough to prevent loss of concrete mortar.
4. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
5. Do not use rust-stained steel form-facing material.
6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
7. Treat the facing of forms with suitable form oil before concrete is placed. Apply oil before the reinforcement is placed. Wet form surfaces which will come in contact with the concrete immediately before the concrete is placed.
8. At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter at the time. Forms for slab, beam and girder construction shall not have tie wire cuttings, nails or any other matter which would mar

the appearance of the finished construction. Clean forms and keep them free of foreign matter during concrete placement.

B. Where aluminum anchors, aluminum shapes, or aluminum electrical conduits are embedded in concrete, paint aluminum contact surfaces with zinc rich primer. Allow the paint to thoroughly dry before placing the aluminum in contact with the concrete.

C. Placement:

1. Set and maintain forms to the lines designated, until the concrete is sufficiently hardened to permit form removal. If, at any stage of the work, the forms show signs of bulging or sagging, immediately remove that portion of the concrete causing this condition. If necessary, reset the forms and securely brace against further movement.

2. Provide adequate cleanout openings where access to the bottom of the forms is not otherwise readily attainable.

3. Chamfer exterior corners and edges of permanently exposed concrete.

4. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

5. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. Carefully and accurately place and support reinforcement in concrete structures.

D. Removal: Remove forms so that the underlying concrete surface is not marred or damaged in any way. Forms shall not be removed until the concrete has attained sufficient strength to safely carry the dead load, but in no case less than the number of curing days set forth in the following table:

Forms	Curing Days
Forms for concrete of minor structural load carrying importance	1 day
Forms for walls, columns, sides of drilled shafts, massive structural components and other members not resisting a bending moment during curing	1 day
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans < or = 10 feet)	7 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 10 feet and < or = 20 feet)	14 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 20 feet)	21 days

E. Reuse:

1. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

2. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Owner's Representative.

END OF SECTION

03 21 00 REINFORCING STEEL

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor and reinforcing materials required to cut, bend, tie, splice, place and support the reinforcement in the material grades, sizes, quantities and locations specified.

1.02 QUALITY ASSURANCE

A. Tolerances: Reinforcement shall be placed where specified, with the following maximum tolerances, plus or minus:

1. Concrete Cover: 1/4 inch.
2. Rebar Spacing: 1/4 inch in 12 inches.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings: Reinforcing bar layout drawing with bar lists clearly marked and referenced to the Drawings. Include:
   a. Material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement.
   b. Additional reinforcement required for openings through concrete structures.
2. Record Data: Manufacturers’ literature for specified products.
3. Certified Test Reports: Certification of steel quality, size, grade and manufacturer’s origin.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ASTM International (ASTM) Standards:

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

2. American Concrete Institute (ACI) Publications:

ACI 301	Specification for Structural Concrete
ACI SP-66	ACI Detailing Manual
ACI 318	Building Code Requirements for Structural Concrete

3. Concrete Reinforcing Steel Institute (CRSI) Publications:

CRSI	Manual of Standard Practice

1.05 DELIVERY AND STORAGE

A. Store steel reinforcement above the surface of the ground upon platform skids or other supports. Protect from mechanical and chemical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the Work, steel reinforcement shall be free from dirt, scale, dust, paint, oil and other foreign material. Tag and store steel reinforcement for ease of correlation with Shop Drawings.

1.06 JOB CONDITIONS

A. Proposed deviations from reinforcing indicated on the Drawings or Specifications shall be approved in writing by the Engineer prior to fabrication.

B. Lap lengths shall be of the length shown on the Drawings or noted in lap and embedment table, and shall be in compliance with ACI 318.

C. Specified cover for reinforcing shall be maintained throughout construction. Bars shall be cut to lengths necessary to allow for proper clearances. Cover of concrete shall be measured from face of forms to outside face of reinforcement.

D. Stirrups shall be hooked.

2.00 PRODUCTS

2.01 MATERIALS

A. Steel Reinforcing Bars: Billet-steel bars for concrete reinforcement conforming to ASTM A615, Grade 60, deformed, with minimum yield strength of 60,000 psi. Steel reinforcing bars shall be produced in the United States of America.

B. Welded Wire Reinforcement: Cold-drawn steel wire conforming to ASTM A1064; flat sheets fabricated in accordance with ASTM A1064.

C. Joint Dowel Bars: Plain-steel bars, ASTM A615, Grade 60. Cut bars true to length with ends square and free of burrs.

D. Supports (Chairs): Bar supports shall be of the proper type for the intended use.

1. Exposed Surface: CRSI Class 1 – Maximum Protection – uniform high density polyethylene (plastic) or fiberglass reinforced plastic (FRP). Plastic protected wire bar supports are not allowed.

2. Unexposed Surface: CRSI Class 3 – No Protection.

E. Spacers: Precast mortar blocks with a 28-day compressive strength that is greater than the specified concrete strength in which the blocks are being placed.

F. Mechanical Bar Splices: Cadweld splices as manufactured by Erico Products, Inc., or approved equal, installed in strict accordance with the manufacturer's instructions and recommendations. The mechanical devices shall develop at least 125 percent of the specified yield of the spliced bars.

G. Mechanical Threaded Splices: Mechanical threaded connections shall utilize a metal coupling sleeve with internal threads which engage threaded ends of the bars to be spliced and shall develop in tension or compression 125 percent of the specified yield strength of the bar.

2.02 FABRICATIONS

A. Bending: Reinforcement shall be bent cold by machine to shapes indicated on the Drawings; true to shapes indicated; irregularities in bending shall be cause for rejection. Unless otherwise noted, all hook and bend details and tolerances shall conform to the requirements of ACI SP-66 and ACI 318.

3.00 EXECUTION

3.01 PREPARATION

A. Before any concrete is placed, all mortar blocks to be used for holding steel in position adjacent to formed surfaces shall be cast in individual molds, after which time the blocks shall be immersed in water for the remainder of at least a 4-day curing period. The blocks shall be cast with the sides beveled and in such a manner that the size of the block increases away from the surface to be placed against the forms. Blocks shall be in the form of a frustum of a cone or pyramid. Suitable tie wires shall be provided in each block for anchoring the block to the reinforcing steel, and to avoid displacement when placing the concrete. The size of the surface to be placed adjacent to the forms shall not exceed 2-1/2 inches square or the equivalent thereof when circular or rectangular areas are provided. Blocks shall be accurately cast to the thickness required, and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

3.02 INSTALLATION

A. General: Place the reinforcement carefully and accurately in the concrete structures. Rigidly tie and support the reinforcement. Welding of any type of reinforcement shall not be permitted.

B. Splices:

1. Splicing of bars, except where indicated on the Drawings, shall not be permitted unless approved by the Engineer prior to fabrication. Splices shall be kept to a minimum. Splices shall preferably occur at points of minimum stress. Lap splices which are permitted shall have a lap in accordance with ACI 318. Rigidly clamp or wire the bars at all splices, in accordance with ACI. Overlap sheets of wire fabric sufficiently to maintain a uniform strength and securely fasten.

2. Welding of reinforcing steel splices shall not be permitted.

3. Make mechanical splices where shown on the Drawings using Cadweld splices or approved equal, installed in accordance with the manufacturer's instructions and

recommendations. The mechanical device shall develop at least 125 percent of the specified yield strength of the bar.

C. Placement:

1. Place steel reinforcement, as indicated on the Drawings with the specified tolerances. Hold securely in place during the placing of the concrete. The minimum clear distance between bars shall be per ACI 318 unless noted otherwise. Always pass vertical stirrups around the main tension members and securely attach thereto. Wire reinforcing together at a sufficient number of intersections to produce a sound, sturdy mat or cage of reinforcement that will maintain the reinforcement in correct positions when the concrete is placed.

2. Hold the reinforcing steel in concrete slabs firmly in place with wire supports or "chairs." Sizing and spacing of the chairs shall be sufficient to properly support the steel, and shall be in accordance with CRSI Publications "Manual of Standard Practice in."

3. Space the reinforcing steel in concrete walls the proper distance from the face of the forms, as indicated on the Drawings:

   a. For wall surfaces exposed to view, use chairs.

   b. For wall surfaces not exposed to view, use chairs or precast mortar blocks.

4. Where reinforcing conflicts with location of anchor bolts, inserts, etc., submit prompt notifications so that revisions can be made before concrete is placed. No cutting of reinforcing shall be permitted without the prior approval of the Engineer.

5. Welded wire shall be fabricated flat sheets, in longest practical lengths. Lap joints one mesh. Do not locate end laps over beams of continuous structures or midway between supporting beams. Offset end laps of adjacent widths to prevent continuous lap. Fasten ends and sides of welded wire fabric at 48 inches on centers with tie wire.

6. Reinforcing shall extend through construction joints.

7. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.03 FIELD QUALITY CONTROL

A. Concrete shall not be placed until the Engineer has observed the final placing of the reinforcing steel, and has given permission to place concrete.

END OF SECTION

03 30 00 CAST-IN-PLACE CONCRETE

1.00 GENERAL

1.01 SUMMARY

A. Furnish labor, materials, mixing and transporting equipment and incidentals necessary to proportion, mix, transport, place, consolidate, finish, and cure concrete in the structure.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and silica fume; subject to compliance with requirements.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings:

a. Mix Design: For each mix design, provide documentation using field test data or trial mixture data in accordance with ACI 301, which includes average strength documentation using either field strength test data or trial mixtures.

b. Submit a schedule to the Owner’s representative which shows the sequence of concrete placements.

c. If joints are not detailed on the Drawings, construction joint details and locations shall be submitted to the Engineer for approval.

2. Certified Test Reports:

a. Materials used in the mix design and which will be used during production of concrete for the project.

b. Water: Verification that all potable mix water and curing water sources do not exceed the non-potable water limits listed in ASTM C1602 Table 2.

1). Test mix water chloride content as indicated in ASTM C1602 Table 2.

c. Aggregate, conforming to ASTM C33, including the test reports for soundness and abrasion resistance.

d. Aggregate:

1). Verification that aggregate is not “potentially reactive” per ASTM C1260.

2). Or a cement chemical analysis indicating that the total alkali content is acceptable per Paragraph 2.02.A.

3). Test all aggregate sources for chlorides in accordance with ASTM C1524.

e. 7-day and 28-day compressive strength tests results.

f. If the sum total of chlorides in mix water and aggregates exceeds 80 percent of the specified limit for hardened concrete, then prior to use of concrete, test mix design to verify acceptable chloride ion concentrations in accordance with ASTM C1218.

3. Record Data:

a. Manufacturer's literature on specified materials.

b. Documentation indicating conformance with ASTM C94 requirements.

1). Concrete delivery tickets in accordance ASTM C94.

c. Documentation of supplier's National Ready Mixed Concrete Association certification.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications:

1. A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

2. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Testing Agency Qualifications:

1. An independent testing agency, acceptable to authorities having jurisdiction and the Engineer, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated.

2. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver cement in bulk or bags which are plainly marked with the brand and manufacturer's name. Immediately upon receipt, store cement in a dry, weather-tight, and properly ventilated structure which excludes moisture. Storage facilities shall permit easy access for inspection and identification. Cement not stored in accordance with the requirements shall not be used.

B. Sufficient cement shall be in storage to complete placement of concrete started. In order that cement may not become unduly aged after delivery, maintain records of delivery dates. Use cement which has been stored at the Site for 60 days or more before using cement of lesser age. No cement shall be used which is lumped, caked, stored more than 90 days, or whose temperature exceeds 170 F.

1.06 STANDARDS

A. Mixing, sampling, placing, curing and testing of concrete, and the materials used shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents. The Contractor shall maintain one copy of each of the applicable standards at the construction field office.

1. ASTM International (ASTM) Standards:

ASTM Standards	
ASTM C31	Standard Practice for of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specification of Ready Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C579	Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

ASTM Standards	
ASTM C580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Stages of Cylindrical Specimens of Cementitious Mixtures
ASTM C845	Standard Specification for Expansive Hydraulic Cement
ASTM C881	Standard Specification for Epoxy Resin Base Bonding Systems for Concrete
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	Standard Specification for Silica Fume used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Standard Test Method for Rubber Property Durometer Hardness
ASTM D6690	Standard Specification for Joint and Crack Sealant, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

2. American Concrete Institute (ACI) Standards:

ACI Standards	
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavy-weight, and Mass Concrete
ACI 301	Specification for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures

3. Federal Specification:
    a. TT S 00227E - Type II, Class A or B, Expansion Joint Sealant.
4. Concrete Plant Manufacturers Bureau (CPMB) Standards:
    a. Concrete Plant Standards.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
    1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
    2. Products: Subject to compliance with requirements, provide one of the products specified.
    3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
    4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONCRETE MATERIALS

A. Cementitious Material; General: If the fine and/or coarse aggregates test "Potentially Reactive", in accordance with ASTM C1260, then a low alkali cementitious material shall be used. A low alkali cementitious material shall be such that, the Sodium Oxide Equivalent ($N_{a2}O_{eq}$) shall not exceed 0.6 percent of the total cementitious material content.

B. Cement; Type: Type I or I/II Portland cement, conforming to ASTM C150; used for all concrete, unless noted otherwise.

C. Supplementary Cementitious Materials (SCM):
    1. Fly Ash/Pozzolans: Conforming to ASTM C618, Class F fly ash; used in all classes of concrete. If fly ash is not available then provide a straight cement mix.

D. Coarse Aggregate:
    1. Crushed stone or gravel conforming to ASTM C33, in the gradation size specified.
        a. Class: Negligible weathering region, but not less than 1N.
        b. Aggregate shall have a coefficient of thermal expansion (CoTE) of 4.5 microstrain per degree Fahrenheit.
    2. For gradation size number 467, a maximum aggregate size of 1-1/2 inches is:

Sieve Size	Percent Retained	Percent Passing
2"	0	100

Sieve Size	Percent Retained	Percent Passing
1-1/2”	0-5	95-100
3/4”	30-65	35-70
3/8”	70-90	10-30
No. 4	95-100	0-5

3. For gradation size number 57, the maximum aggregate size of 1 inch is:

Sieve Size	Percent Retained	Percent Passing
1-1/2”	0	100
1”	0-5	95-100
1/2”	40-75	25-60
No. 4	90-100	0-10
No. 8	95-100	0-5

4. For gradation size number 67, the maximum aggregate size of 3/4 inch is:

Sieve Size	Percent Retained	Percent Passing
1”	0	100
3/4”	0-10	90-100
3/8”	45-80	20-55
No. 4	90-100	10-10
No. 8	90-100	0-5

E. Fine Aggregate:

1. Washed and screened natural sands or sands manufactured by crushing stones; conforming to ASTM C33. The gradation in ASTM C33 for air entrained concrete is:

Sieve Size	Percent Retained	Percent Passing
3/8”	0	100
#4	0-5	95-100
#8	0-20	80-100
#16	15-50	50-85
#30	40-75	25-60
#50	70-90	10-30

2. Fine aggregate shall have not more than 45 percent retained between any two consecutive sieves. Its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

F. Water: Potable and complying with ASTM C1602 and ASTM C1602 Table 2.

2.03 ADMIXTURES

A. Measure and dose admixtures in accordance with manufacturer's recommendations.

B. Air Entraining Admixture: Conforming to ASTM C260.

C. Water Reducing Admixtures: Conforming to ASTM C494; Types A or D.

D. Set Retarding Admixtures: Conforming to ASTM C494; Types B and D.

E. Water Reducing Admixtures, High Range (HRWR): High Range Water Reducer shall comply with ASTM C494, Type F or G. HRWR shall be added to the concrete mix at the concrete batch plant. HRWR may not be added at placement site except to redose a batch and only after approval of the HRWR manufacturer. The high range water reducing admixture shall be able to maintain the plasticity range without significant loss of slump or rise in concrete temperature for 2 hours. Other admixtures may only be used with the HRWR if approved by the HRWR manufacturer. A representative of the HRWR manufacturer shall be present during any large placement, placement of slabs, or during times of unusual circumstance which may require changes to the product formulation.

   1. Manufacturers:

      a. GCP Applied Technologies.

      b. Master Builders Solutions US LLC.

      c. Sika Corporation.

2.04 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Unless indicated otherwise, provide the following configurations.

   1. Construction Joints:

      a. Profile: Ribbed without center bulb.

      b. Width: 6 inches.

      c. Minimum thickness: 3/8 inch.

   2. Expansion Joint:

      a. Profile: Ribbed with center bulb.

      b. Width: 9 inches.

      c. Minimum thickness: 3/8 inch.

   3. Manufacturers:

      a. Sika Greenstreak and Sika Westec Barrier Technologies.

      b. W.R. Meadows, Inc.

      c. Paul Murphy Plastics Co.

      d. Progress Unlimited Inc.

      e. DCA Construction Products, LLC: Durajoint Waterstop.

f. Vinylex Corporation.

B. Self-Expanding Strip Waterstops (Hydrophilic): Self-expanding strip waterstops shall be used only where specifically indicated. Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophilic material for adhesive bonding to concrete.

1. Products:

a. De Neff Swellseal Joint; GCP Applied Technologies.

b. Adeka Ultra Seal; Mitsubishi International Corporation.

c. Sika Hydrotite; Sika Corporation – U.S.

2.05 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape for sealing lap joints, penetrations, and as required for securing terminations.

1. Available Products:

a. Fortifiber Corporation; Moistop Ultra A.

b. Raven Industries Inc.; Vapor Block 15.

c. Reef Industries, Inc.; Griffolyn Type-105.

d. Stego Wrap (15-mil) Vapor Barrier; STEGO INDUSTRIES LLC.

e. Huskey Yellow Guard, 15-mil Vapor Barrier; Poly-America, L.P.

2.06 CURING MATERIALS

A. Sheet Curing Material: Conforming to ASTM C171.

1. Waterproof paper.

2. Polyethylene film.

3. White burlap - polyethylene film.

4. AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd. dry.

B. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Products:

a. Polyseal WB-15; ChemMasters.

b. UV Safe Seal; Lambert Corporation.

c. Lumiseal Plus; Laticrete International, Inc.

d. MasterKure CC 1315 WB; Master Builders Solutions US LLC.

e. Vocomp-30; W.R. Meadows, Inc.

f. Vexcon Starseal 1315; Vexcon Chemicals, Inc.

g. Approved equal.

C. Finishing Aid: Spraying material designed to form a monomolecular film on fresh concrete that reduces the rate of evaporation of surface moisture prior to finishing. This material is not a curing compound. Concrete must be cured as specified.

1. MasterKure ER 50; Master Builders Solutions US LLC.

2. Approved equal.

2.07 RELATED MATERIALS

A. Joint Materials for Water-Retaining Structures:

1. Pre-molded, resilient, non-bituminous expansion joint filler conforming to ASTM D1752, Type "II", in the thickness specified.

2. Joint sealer conforming to ASTM D6690.

3. Expansion joint sealant for non-potable water shall be a two-component, non-sag, polysulfide-base, elastomeric sealing compound. The material shall conform to Federal Specification TT S 00227E, Type "II", Class B; installed according to the manufacturer's recommendations. Backing material for sealant shall be a rod of a diameter and composition recommended by the sealant manufacturer.

4. Expansion joint sealant for potable water shall be a two-component, non-sag, polysulfide sealant containing no lead or mercury; conforming to Fed. Spec. TT S 00227E, Type "II", Class A; applied according to the manufacturer's specifications. Backing material for sealant shall be a rod of a diameter and composition recommended by the sealant manufacturer.

5. Where surface is to receive a swept in grout topping, a 3-inch wide, 1-mil polyethylene strip shall be placed above the joint sealant and held in place with 1-inch wide polyethylene tape spaced at 12-inch centers (maximum).

B. Joint Materials for Non-Water-Retaining Structures:

1. Bituminous-type, preformed, expansion joint filler; conforming to ASTM D994.

2. Pre-molded, resilient, non-bituminous expansion joint filler conforming to ASTM D1752, Type I, in the thickness specified.

C. Bonding Agent: Water-based epoxy modified, with integral corrosion inhibitor. Install according to the manufacturer's recommendations.

1. Sika Armatec 110 EpoCem; Sika Corporation.

2. MasterEmaco P 124; Master Builders Solutions US LLC.

3. Approved equal.

D. Non-Shrink Grout:

1. General: Non-shrink grout for grouting of pump, motor, and equipment baseplates or bedplates, column baseplates, other miscellaneous baseplates, piping block outs and

other uses of grout. Grout shall meet the following requirements, as verified by independent laboratory tests:

a. No shrinkage from the time of placement, or expansion after set, under ASTM C827 and CRD C621 83 (Corps of Engineers). When non-shrink grouts are tested under CRD C621 83, the grout shall be tested in a fluid state. A fluid state shall be defined as flowing through a flow cone at a rate of 20 seconds, plus or minus 5 seconds.

b. An initial set time of not less than 45 minutes under ASTM C191.

2. Non-Shrink Non-Metallic Grout: Pre-mixed, non-staining, non-shrink grout; minimum 28-day compressive strength of 5000 psi.

a. Do not use for vibrating equipment.

b. Products:

1). MasterFlow 100; Master Builders Solutions US LLC.

2). Five Star Grout; Five Star Products, Inc.

3). SikaGrout 212; Sika Corporation.

3. Non-Shrink Epoxy Structural Grouts: Furnished in two components from the factory and mixed on the Site; conforming to ASTM C579, ASTM C580, and ASTM C827; chemical resistant, water resistant and a minimum 7-day compressive strength of 12,000 psi.

a. Use for vibrating equipment.

b. Products:

1). Sikadur 42, Grout-Pak; Sika Corporation.

2). Five Star HP Epoxy Grout; Five Star Products, Inc.

3). MasterFlow 648; Master Builders Solutions US LLC.

E. Normal Shrinkage Grout: 1 part Portland cement, Type I or I/II , to 3 parts of clean, first quality sand; proportioning on a volumetric basis; used for non-structural applications for grouting areas as shown on the Drawings which do not require non-shrink grout.

F. Foundation Waterproofing: Foundation coating shall be used only on the exterior of concrete walls not exposed to view.

1. MasterSeal 581 (Thoroseal); Master Builders Solutions US LLC.

2. TREMproof 250GC; Tremco Commercial Sealants and Waterproofing.

3. Approved equal.

G. Zinc Rich Primer: Aluminum surfaces which contact or are embedded in concrete shall be coated with zinc rich primer. Primer shall be:

1. Tneme-Zinc; Tnemec Company, Inc.

2. MasterProtect P 8100AP; Master Builders Solutions US LLC.

3. Approved equal.

2.08 REPAIR MATERIALS

A. Structural Concrete Repair Material: Low-shrink, non-slump, non-metallic, quick setting patching mortar; as approved by the manufacturer for each application and applied accordance with the manufacturer's recommendations.

1. Products:

a. Five Star Structural Concrete; Five Star Products, Inc.

b. SikaTop 123; Sika Corporation.

c. SikaTop 122; Sika Corporation.

d. MasterEmaco N 425; Master Builders Solutions US LLC.

e. Approved equal.

2.09 CONCRETE MIXTURES

A. Design Criteria:

1. Provide a mix design for each concrete application indicated. This may necessitate multiple mix designs for each class of concrete depending on HRWR, entrained air, and other requirements.

2. All Concrete shall be normal weight concrete composed of Portland cement, fine aggregate, coarse aggregate, admixtures, and water, as specified.

3. ACI 211.1 shall be the basis for selecting the proportions for concrete made with aggregates of normal and high density and of workability suitable for usual cast in place structures.

4. The workability of any mix shall be as required for the specific placing conditions and the method of placement. The concrete shall have the ability to be worked readily into corners and around reinforcing steel without the segregation of materials or the collection of free water on the surface. Compliance with specified slump limitations shall not necessarily designate a satisfactory mix.

5. In no case shall the amount of coarse material produce harshness in placing or honeycombing in the structure, when forms are removed. The maximum amount of coarse aggregate (dry loose volume) per cubic foot of finished concrete shall not exceed 0.82 cubic feet.

6. In calculating water-cement ratio: The water content shall include the amount of water batched or to be added later, plus the free water in the aggregate, and minus the water content at SSD conditions.

7. No allowance shall be made for the evaporation of water after batching. If additional water is required to obtain the desired slump, a compensating amount of cement shall also be added. In no case shall the maximum water cement ratio exceed the specified maximum or that of the approved mix design.

8. Air Entrainment: Provide the percent air entrainment in each concrete mix design as recommended by ACI 350:
    a. Exposure Class: F2, unless otherwise specified/restricted:
9. Maximum water-soluble chloride ion content in concrete, by percent weight of concrete, shall not exceed ACI 350 Exposure Class C1.
10. When job conditions dictate, water-reducing and set-controlling admixtures may be used. Only specified admixtures shall be used. Admixtures shall be batched at the batch plant.
11. High Range Water Reducer (HRWR): Provide HRWR in mix designs for the following specified applications:
    a. Drilled shafts, footings, walls, columns, and beams.
    b. Interior of building curbs which are not cast monolithically with slabs.
    c. Precast concrete.
    d. Exception: Do not provide HRWR in slabs and pavement (a water reducer is permitted provided performance requirements are met).
12. If fly ash is to be used in place of cement, no more than 25 percent of the cement may be replaced.
13. Concrete shall be capable of developing two-thirds of the required 28-day compressive strength in 7 days.

B. Concrete Classifications:

Class	Min. 28-Day Compressive Strength (psi)	Max. Size Aggregate (inches)	Max. Water: Cementitious Materials Ratio	Slump +/-1 (inches)	Min. Sacks of Cement Per Cubic Yard **
A	4500	1.5 Size No. 467	0.45	3 (8*)	6.00
B	3000	1.5 Size No. 467	0.47	3	6.00
C	4500	1.0 Size No. 57	0.45	4 (8*)	6.00
D	5000	0.75 Size No. 67	0.47	4	6.25
E	1500	1.5 Size No. 467	0.70	4	4.25
* Slump shown is with HRWR ** Provide one additional sack of cement per cubic yard if concrete must be deposited in standing water.					

C. Concrete Usage:

Class	Usage
Class A Use	Footings and slabs, and other unless noted otherwise
Class B Use	Pavement, gutters, sidewalks
Class C Use	Walls, columns, beams, drilled shafts
Class D Use	Precast concrete and precast panels
Class E Use	Cradling, blocking, mud slab, lean concrete backfill

D. Required Average Compressive Strength:

1. All concrete is required to have an average compressive strength greater than the specified strength. The required average compressive strength shall be established according to the requirements of ACI 301.

2. Standard Deviation: Calculate a standard deviation and establish the required average compressive strength (fcr') in accordance with ACI 301. If field test records are not available, select the required average strength from ACI 301.

E. Documentation of Required Average Compressive Strength:

1. Documentation indicating the proposed concrete proportions will produce an average compressive strength equal to or greater than fcr'. Documentation shall consist of field strength records or trial mixture.

2. Field Strength Test Records: Document field strength test records according to ACI 301, which is partially restated here:

   a. If field test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days, verify that the average of the field test results equals or exceeds fcr'.

   b. If the field test data represent two groups of strength tests for two mixtures, plot the average strength of each group versus the water-cementitious materials ratio of the corresponding mixture proportions and interpolate between them to establish the required mixture proportions for fcr'.

3. Trial Mixtures:

   a. Establish trial mixture proportions according to ACI 301, which is partially restated here:

      1). Make at least three trial mixtures complying with performance and design requirements. Each trial mixture shall have a different cementitious material content. Select water-cementitious materials ratios that will produce a range of compressive strengths encompassing fcr'.

      2). Submit a plot of a curve showing the relationship between water-cementitious materials ratio and compressive strength.

      3). Establish mixture proportions so that the maximum water-cementitious materials ratio is not exceeded when the slump is at the maximum specified.

b. Trial mixtures shall be designed, sampled, and tested by an independent testing laboratory, retained and paid by the Contractor and approved by the Owner.

c. Provide 7-day and 28-day strengths test results.

4. Revisions to concrete mixtures:

a. When less than 15 compressive strength tests results for a given class of concrete are available from the current Project:

1). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

a). A 7-day compressive strength test result multiplied by 1.5 falls below the required 28-day compressive strength.

b). A 28-day compressive strength test result is deemed not satisfactory.

b. When at least 15 compressive strength test results for a given class of concrete become available from the current Project:

1). Calculate the actual average compressive strength, standard deviation and required average compressive strength using the previous 15 consecutive strength tests. Submit results in graphical form with each 28-day test result for that class of concrete.

2). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

a). A 7-day compressive strength test result multiplied by the average job-to-date ratio of 7-day to 28-day compressive strength falls below the required 28-day compressive strength.

b). A 28-day compressive strength test result is deemed not satisfactory.

c). The average compressive strength falls below the required average compressive strength.

c. When revisions to the mix design are required, notify the Engineer in writing of the corrective actions taken.

2.10 OFF-SITE BATCH PLANT

A. Batch plants shall be an established concrete batching facility meeting the requirements of the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

2.11 CONCRETE MIXING

A. Mixers may be stationary, truck, or paving mixers of approved design. They shall be capable of combining the materials into a uniform mixture and of discharging without mixture segregation. Stationary and paving mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixers or mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer on the name plate.

B. The mixing time for stationary mixers shall be based upon the mixer's ability to produce uniform concrete throughout the batch and from batch to batch. For guidance purposes, the manufacturer's recommendations, or 1 minute for 1 cubic yard plus 1/4 minute for each additional cubic yard may be used. Final mixing time shall be based on mixer performance. Mixers shall not be charged in excess of the capacity specified by the manufacturer.

C. When a stationary mixer is used for partial mixing of the concrete (shrink mixed), the stationary mixing time may be reduced to the minimum necessary to intermingle the ingredients (about 30 seconds).

D. When a truck mixer is used, either for complete mixing (transit-mixed) or to finish the partial mixing in a stationary mixer and in the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum, at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If the batch is at least 1/2 cubic yard less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to no less than 50. Additional mixing shall be performed at the speed designated by the manufacturer of the equipment as agitating speed. When necessary for proper control of the concrete, mixing of transit-mixed concrete shall not be permitted until the truck mixer is at the Site of the concrete placement. Truck mixers shall be equipped with accurate revolution counters.

E. Paving mixers may be either single compartment drum or multiple compartment drum type. A sled or box of suitable size shall be attached to the mixer under the bucket to catch any concrete spillage that may occur when the mixer is discharging concrete into the bucket. Multiple compartment drum paving mixers shall be properly synchronized. The mixing time shall be determined by time required to transfer the concrete between compartments of the drum.

F. Vehicles used in transporting materials from the batching plant to the paving mixers shall have bodies or compartments of adequate capacity to carry the materials and to deliver each batch, separated and intact, to the mixer. Cement shall be transported from the batching plant to the mixers in separate compartments which are equipped with windproof and rain proof covers.

3.00 EXECUTION

3.01 PREPARATION

A. Notify the Owner's representative upon completion of various portions of the work required for placing concrete, so that inspection may be made as early as possible. Keep the Owner's representative informed of the anticipated concrete placing schedules.

B. All items, including lines and grades, forms, waterstops, reinforcing, inserts, piping, electrical, plumbing and the Contractor's concreting materials and equipment shall be in compliance with the Contract Documents before proceeding.

C. Do not place any concrete until formwork and the placing reinforcement in that unit is complete. Place no concrete before the completion of all adjacent operations which might prove detrimental to the concrete.

D. Brilliantly light the Site so that all operations are plainly visible when concrete mixing, placing, and finishing, continues after daylight. Whenever possible, concrete finishing shall be completed in daylight hours.

E. When placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust and other extraneous matter. Forms for slab, beam and girder construction shall not have tie wire cuttings, nails, or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of any foreign matter during concrete placing.

F. The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the time limits specified shall not be used. Concrete shall not be re-tempered.

G. Concrete shall not be placed if impending weather conditions would impair the quality of the finished Work.

H. Unless otherwise provided, the following requirements shall govern the time sequence on which construction operations shall be carried.

1. Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured for at least 2 curing days. Concrete may be placed in a wall or column as soon as the forms and reinforcing steel placements are approved.

2. Steel beams or forms and falsework for superstructures shall not be erected on ground-supported concrete substructures until the substructure concrete has cured for at least 4 curing days.

3. Falsework required for superstructures shall not be erected until the substructure has cured for 4 curing days, and shall not be removed until allowed for by Section 03 11 00 “Concrete Forming.”

3.02 EMBEDDED ITEMS

A. Where aluminum anchors, aluminum shapes, or aluminum electrical conduits are embedded in concrete, paint aluminum contact surfaces with zinc rich primer. Allow the paint to thoroughly dry before placing the aluminum in contact with the concrete.

B. Paint steel or other ferrous metal to be mounted on or placed in contact with dry/cured concrete, and coat in accordance with Section 09 96 00.01 “High-Performance Coatings” prior to installation.

C. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.

3.03 VAPOR RETARDERS

A. Place, protect, and repair vapor-retarder sheets according to ASTM E1643 and manufacturer's written instructions. At a minimum, provide the following:

1. Lap sheets not less than six inches at all joints. Use pressure-sensitive tape at all laps. Lap reinforcement directly over film before placing concrete, taking precautions to prevent punctures.

2. Carefully cut film around pipes and wiring outlets. Install reinforcing sheets and apply pressure sensitive tape around penetrations as recommended by the manufacturer.

3. Terminate vapor barrier as indicated on the Drawings.

B. Granular fill below vapor retarder sheet shall be smoothed and free of protrusions that might damage or rupture the sheet.

C. Completely cover subgrade with the vapor retarder sheet as indicated on the Drawings.

3.04 JOINTS

A. Expansion Joints and Devices:

1. Workmanship: Exercise careful workmanship in joint construction to separate the concrete sections by an open joint or by the joint materials, and make the joints true to the outline indicated.

2. Expansion Joints: Construct expansion joints and devices to provide expansion and contraction. Construct joints which are to be left open or filled with poured joint material with forms which are adaptable for loosening or early removal. In order to avoid jamming by the expansion action of the concrete and the consequent likelihood of injuring adjacent concrete, remove or loosen these forms as soon as possible after the concrete has initially set. Make provisions for loosening the forms to permit free concrete expansion without requiring full removal.

3. Armored Joints: Carefully construct armored joints to avoid defective anchorage of the steel and porous or honeycombed concrete adjacent to same. Anchor pre-molded materials to the concrete on one side of the joint with approved adhesive. Anchor so that the material does not fall out of the joint.

B. Construction Joints:

1. Construction joints are formed by placing plastic concrete in direct contact with concrete which has attained its initial set. When concrete is specified as monolithic, the term shall be interpreted as the manner and sequence of concrete placement so that construction joints do not occur.

2. Additional horizontal and vertical construction joints, when submitted and approved by the Engineer, may have an impact on reinforcing details. Revise reinforcing details to reflect additional joints.

3. Unless otherwise provided, construction joints shall be square and normal to the forms. Provide bulkheads in the forms for all joints except horizontal joints.

4. Clean horizontal construction joints for receiving the succeeding lift using air water cutting. The surface shall be exposed sound, clean aggregate with a 1/4 inch amplitude. After cutting, wash the surface until there is no trace of cloudiness in the wash water.

5. In areas where air water cutting cannot be satisfactorily accomplished, or in areas where it is undesirable to disturb the surface of the concrete before it has hardened, prepare the surface for receiving the next lift by wet sand blasting to immediately remove all laitance and unsound concrete prior to placing of the next lift. Thoroughly wash the surface of the concrete after sand blasting to remove all loose material.

6. Provide construction joints with concrete keyways, reinforcing steel dowels, and waterstops where indicated on the Drawings. The method of forming keys in keyed joints shall permit the easy removal of forms without chipping, breaking, or damaging the concrete.

7. Construction joint layout unless otherwise indicated on Drawings:

   a. Maximum horizontal spacing of construction joints shall be 45 feet.

   b. Maximum vertical spacing of construction joints shall be 15 feet.

C. Control Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness, spaced as indicated on the Drawings, and as follows:

1. Tooled Joints: Form control joints after initial floating by tooling/grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

D. Hardened Concrete: Where new concrete or grout is to be placed in contact with existing or recently hardened concrete, texture the existing or recently hardened surface by chipping or other means so that an irregular surface having a height variance of not less than 1/4 inch is created. The existing or recently hardened concrete shall then be coated with a bonding agent and new concrete or grout placed.

3.05 WATERSTOPS

A. PVC/TPER/PE Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work.

1. At formed surfaces, a split form shall be used. The split form shall have a tight fit which prevents misalignment and concrete leakage.

2. The embedded flange of the waterstop must be secured prior to concrete placement. The flange shall be secured at 12 inches on-center by factory installed hog rings or grommets at the outermost rib. Never place nails or screws through the body of the waterstop.

3. All fittings and changes in direction shall be factory fabricated. Only straight butt splices shall be made in the field. Field splices shall be according to the manufacturer's written instructions and as follows:

   a. Cut adjoining ends square to form matching edges.

b. Uniformly melt the ends at 380 F using a thermostatically controlled, Teflon coated splicing iron.

c. When a 1/8-inch diameter melt bead develops on each waterstop end, remove the splicing iron and firmly press the two ends together in proper alignment. Hold until the material has fused and cooled. Allow the splice to cool naturally; do not quench.

B. Self-Expanding Strip Waterstops:

1. Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place.

a. Waterstop shall be bonded to the substrate using a continuous bead of swelling sealant or adhesive as recommended by the manufacturer.

1). ADEKA Ultra Seal P-201.

2). Sika Leakmaster.

2. Install in longest lengths practicable.

3. Protect from moisture, oil, dirt, and sunlight prior to the placement of concrete. Coordinate with manufacturer for additional requirements.

3.06 CONCRETE PLACEMENT

A. Cold Weather:

1. If air temperature has fallen to, or is expected to fall below 40 F during the protection period (a minimum of 48 hours but not less than that required by ACI 306.1), then cold weather concreting shall be performed in accordance with ACI 306.1.

2. In cases where the temperature drops below 40 F after the concreting operations have been started, sufficient canvas and framework or other type of housing shall be furnished to enclose and protect the structure, in accordance with the requirements of ACI 306.1. Sufficient heating apparatus to provide heat shall be supplied, and heating source and protection from combustion gas shall be in accordance with ACI 306.1. The concrete shall be protected when placed under all weather conditions. Should concrete placed under such conditions prove unsatisfactory, remove and replace the concrete at no cost to the Owner.

3. When the air temperature is above 30 F:

a. The minimum concrete temperature at the time of mixing shall be 60 F unless other requirements of ACI 306.1 are met, which may allow for a lower mix temperature.

b. The minimum concrete temperature at the time of placement and during the protection period shall be 55 F unless other requirements of ACI 306.1 are met, which may allow for a lower temperature.

4. The means used to heat a concrete mix shall be in accordance with ACI 306.1.

5. Salts, chemicals, or other foreign materials shall not be mixed with the concrete to preventing freezing. Calcium chloride is not permitted.

B. Hot Weather:

1. Hot weather is defined as any combination of high air temperature, low relative humidity, and wind velocity that impairs the quality of the concrete. Hot weather concreting shall be in accordance with ACI 305.1. Concrete shall be placed in the forms without the addition of any more water than that required by the design (slump). No excess water shall be added on the concrete surface for finishing. Control of initial set of the concrete and extending the time for finishing operations may be accomplished with the use of approved water reducing and set retarding admixture, as specified.

2. Maximum time intervals between the addition of mixing water and/or cement to the batch, and the placing of concrete in the forms shall not exceed the following (excluding HRWR admixture use):

Concrete Temperature	**Maximum time From Water Batch to Placement**
Non-Agitated Concrete	
Up to 80 F	30 Minutes
Over 80 F	15 Minutes
Agitated Concrete	
Up to 75 F	90 Minutes
75 F to 89 F	60 Minutes

   a. The use of an approved set-retarding admixture will permit the extension of the above time maximums by 30 minutes, for agitated concrete only.

   b. The use of an approved high range water reducing (HRWR) or hydration-controlling admixture will allow placement time extensions as determined by the manufacturer.

3. The maximum temperature of fresh concrete at time of discharge shall not exceed 95 F. The temperatures of the mixing water shall be reduced by the use of chilled water or ice.

4. The maximum temperature of fresh concrete with high range water reducing admixture shall not exceed 100 F at time of discharge.

5. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.

C. Handling and Transporting:

1. Delivery tickets shall be required for each batch and shall be in accordance with ASTM C94. Each delivery ticket must show plainly the amount of water, in gallons that can be added to the mixer truck at the Site without exceeding the maximum water cement ratio approved for that mix design. Amount of water added must be in proportion to contents of truck.

2. Arrange and use chutes, troughs, or pipes as aids in placing concrete so that the ingredients of the concrete are not segregated. They shall be steel or steel lined. When steep slopes are necessary, equip the chutes with baffles or make in short lengths that reverse the direction of movement. Extend open troughs and chutes, if necessary,

inside the forms or through holes left in the forms. Terminate the ends of these chutes in vertical downspouts.

3. Keep chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water before and after placement. Discharge water used for flushing away from the concrete in place.
4. Use pumping equipment that has sufficient capacity so that:
    a. Discharge of pump concrete does not result in segregation.
    b. Modification of accepted concrete mixture is not required.
5. Carting or wheeling concrete batches on completed concrete floor slab shall not be permitted until the slab has aged at least 4 curing days. Unless pneumatic tired carts are used, wheel the carts on timber planking so that the loads and impact are distributed over the slab. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

D. Depositing:

1. The method and manner of placing shall prevent segregation or separation of the aggregate or the displacement of the reinforcement. Use drop chutes or tremies as necessary.
2. Free Fall: Concrete shall not be allowed to free fall more than 10 feet when HRWR admixture is used or 5 feet without the use of HRWR. Free falling concrete shall avoid striking reinforcing during placement. Placement of concrete for heights exceeding the free fall limit shall be placed using a tremie.
    a. Concrete shall not be allowed to free fall through water. Place as indicated below.
3. Prevent the splattering of forms and reinforcing bars if the splattered concrete will dry or harden before incorporation into the mass.
4. Fill each part of the forms by directly depositing concrete as near its final position as possible. Work the concrete under and around the reinforcement bars. Depositing large quantities at one point in the forms, then running or working it along the forms shall not be permitted.
    a. Place required sections in one continuous operation to avoid additional cold joints. Each layer shall be fluid and concrete shall not have taken initial set when a new layer is placed upon it. Not more than 1 hour shall elapse between the placing of successive concrete layers in any portion of the structures included in continuous placement.
5. Place in continuous horizontal layers with a depth of from 1 to 3 feet. If excessive bleeding causes water to form on the surface of the concrete in tall forms, revise mix design to reduce the bleeding.
6. In tall walls, place the concrete to a point about 1 foot below the top of the wall and allow to settle for 1 hour. Resume and complete concreting before set occurs.
7. For slopes greater than two percent, start concrete placement at low end and proceed upslope.

8. After the concrete has taken initial set, the forms shall not be jarred. No force or load shall be placed upon projecting reinforcement.

E. Consolidating:

1. Compact each layer of concrete and flush the mortar to the surface of the forms by continuous-working mechanical vibrators. Apply the vibrator to the concrete immediately after deposit. Move vibrator throughout the layer of the newly placed concrete, several inches into the plastic layer below. Thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms until it is well-compacted.

2. Mechanical vibrators shall not be operated so that they penetrate or disturb previously placed layers which are partially set or hardened. They shall not be used to aid the flow of concrete laterally. The vibration shall be of sufficient duration to completely compact and embed reinforcement and fixtures, but not to an extent causing segregation.

3. Keep vibrators constantly moving in the concrete and apply vertically at points uniformly spaced, not farther apart than the radius over which the vibrator is visibly effective. The vibrator shall not be held in one location longer than required to produce a liquified appearance on the surface.

4. When submerged in concrete, internal vibrators shall maintain a frequency of not less than 6000 impulses per minute for heads with diameters greater than 5 inches and 10,000 impulses for smaller vibrator heads. The vibration intensity (amplitude) shall be sufficient to produce satisfactory consolidation.

    a. Vibrator head shall be sufficiently small to allow placement between reinforcing steel.

    b. Provide at least one standby vibrator.

    c. Check vibrators intended for regular service or standby service prior to concreting operations.

F. Placement in Water:

1. Deposit concrete in water only when dry conditions cannot be obtained. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water flowing through the space where concrete is to be deposited. Pumping of water shall not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.

2. Carefully place the concrete using a tremie, closed bottom dumping bucket, or another approved method which does not permit the concrete to fall through the water without protection. The concrete shall not be disturbed after being deposited. Regulate depositing to maintain horizontal surfaces.

3. When a tremie is used, it shall consist of a tube constructed in sections having water-tight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work, and shall allow the tremie to be rapidly lowered to retard the flow. The number of times it is necessary to shift the location of the tremie shall be held to a minimum for any continuous placement of concrete. During the placing of concrete, keep the tremie tube full to the bottom of the hopper. When a batch is dumped into the hopper, slightly raise the tremie, but not out

of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. Stop the flow by lowering the tremie. Continue placing operations until the work is completed.

4. When concrete is placed by means of the bottom dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. Lower the bucket gradually and carefully until it rests upon the concrete already placed. Raise it very slowly during the discharge travel to maintain still water at the point of discharge and to avoid agitating the mixture.
5. Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water.

G. Placement in Slabs:

1. Allow concrete in columns, walls and deep beams or girders to stand for at least 1 hour to permit full settlement from consolidation, before concrete is placed for slabs they are to support. Haunches are considered as part of the slab and shall be placed integrally with them.
2. When monolithic slabs are placed in strips, the widths of the strips, unless otherwise specified or indicated, shall insure that concrete in any one strip is not allowed to lie in place for more than 1 hour before the adjacent strips are placed.
3. Immediately before placing concrete, thoroughly dampen the subgrade to receive concrete to prevent moisture absorption from the concrete.
4. As soon as concrete placing is complete for a slab section of sufficient width to permit finishing operations, level the concrete, strike off, tamp and screed. The screed shall be of a design adaptable to the use intended, shall have provision for vertical adjustment and shall be sufficiently rigid to hold true to shape during use.
5. The initial strike off shall leave the concrete surface at an elevation slightly above grade so that, when consolidation and finishing operations are completed, the surface of the slab is at grade elevation.
6. Continue tamping and screeding operations until the concrete is properly consolidated and free of surface voids. Bring the surface to a smooth, true alignment using longitudinal screeding, floating, belting, and/or other methods.
7. When used, templates shall be of a design which permits early removal so satisfactory finishing at and adjacent to the template is achieved.
8. While the concrete is still plastic, straighten the surface as required to achieve specified flatness requirements. Remove high spots and fill depressions with fresh concrete and re-float. Continue to check during the final finishing operation, until the surface is true to grade and free of depressions, high spots, voids, or rough spots.
9. Where floor drains are shown in slabs and sloping the slab is not indicated, slope slab to drain on a grade of 1/16 inch per foot. The thickness of slab at floor drain shall be the thickness of slab as indicated on the Drawings.

H. Placement in Foundations: Place concrete in deep foundations so that segregation of the aggregates or displacement of the reinforcement is avoided. Provide suitable chutes or vertical pipes. When footings can be placed in dry foundation pits without the use of

cofferdams or caissons, forms may be omitted and the entire excavation filled with concrete to the elevation of the top of footing. The placing of concrete bases above mud slab is permitted after the forms are free from water and the seal course cleaned. Execute necessary pumping or bailing during concreting from a suitable sump located outside the forms.

I. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on the Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.07 FINISHING FORMED SURFACES

A. Forms for walls, columns, and sides of beams and girders shall be removed as specified in Section 03 11 00 "Concrete Forming." Patch, repair, finish, and clean concrete after form removal. Finish concrete not more than 7 days after form removal. Cure concrete as finishing progresses.

B. Air voids, for all types of finishes, are defects and shall be removed by rubbing or patching.

C. Finish Schedule:

Type of Finish	Location
No Finish	Surfaces which are not visible from the inside or outside of the completed structure, are more than 12 inches below finish grade, and where a coating/membrane/drainage board will not be installed
Smooth Finish	Surfaces exposed to view, areas below to a point 12 inches below grade, and where a coating/membrane/drainage board will be installed.

D. No Finish: Patch tie holes. Repair defects larger than 1-1/2 inches in diameter or 1/2 inch in deep. Remove projections larger than 1 inch.

E. Smooth Finish: The form facing material shall produce a smooth, uniform texture on the concrete. Patch tie holes. Repair defects larger than 3/4 inch wide or 1/2 inch deep. Remove projections flush with the adjacent surface.

3.08 FINISHING FLOORS AND SLABS

A. General: Screed, restraighten, and finish concrete surfaces. Do not wet concrete surfaces.

B. Finish slabs, platforms, and steps monolithically and apply as indicated on the Drawings and the following schedule of finishes:

Type of Finish	Location
Rough Finish	Tank floors that receive grout topping and slabs which receive additional concrete toppings.
Float Finish	Top of walls, vault top slabs not subject to pedestrian foot traffic.

Type of Finish	Location
Trowel Finish	Interior slab surfaces exposed to view or to be covered with resilient flooring, carpet, and ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
Broom Finish	Exterior concrete platforms, steps, and ramps.

1. Rough Finish: Provide a rough surface by screeding only without further finish.
2. Float Finish: Finish surfaces using a float to a true, even plane with no coarse aggregate visible. In the initial floating, while the concrete is plastic, use sufficient pressure on the float to bring excess moisture to the surface for removal. Apply a final "light float" finish to the surface as the concrete hardens. The surface shall have a uniform granular texture and shall meet the straightness requirements.
3. Trowel Finish:
    a. After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
    b. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 1/8 inch.
4. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

C. Give sidewalks a brush finish, unless noted otherwise. Score sidewalks at a spacing equal to the width of the walk and edge on each side using a tool with a radius of approximately 1/4 inch.

3.09 MISCELLANEOUS CONCRETE ITEMS

A. Normal Shrinkage Grouting:

1. Prior to grout application, thoroughly clean the surface of all foreign matter. Roughen concrete surface to CSP 4 and wet as required for a saturate surface dry condition (SSD). Set forms in place; tight and securely anchored to prevent the loss of grout.
2. The necessary materials and tools shall be on hand before starting grouting operations.
3. After preparing surface and immediately prior to grouting, provide scrub coat of grout material. Do not allow scrub coat to dry prior to placing grout.
4. After mixing, quickly and continuously place the grout to avoid overworking, segregation and breaking down of the initial set. Mix and place the grout where indicated on the Drawings. Cure grout using wet curing method for concrete.

B. Non-Shrink Grout:

1. Obtain field technical assistance from the grout manufacturer, as required, to ensure that grout mixing and installation comply with the manufacturer's recommendations and procedures.

2. Roughen concrete surface as required by the manufacturer, but not less than CSP 4. Saturate the surface to achieve an SSD condition. Baseplates shall be free of oil, grease, laitance and other foreign substances.

    a. Epoxy grout: Surface shall be dry as recommended by the manufacturer.

3. Place grout according to the manufacturer's directions so that spaces and cavities below the bottom of the baseplates are completely filled. Provide forms where structural components of the baseplates do not confine the grout. Trowel finish the non-shrink grout where the edge of the grout is exposed to view and after the grout has reached its initial set. Cut off the exposed edges of the grout at a 45-degree angle to the baseplate, bedplate, member, or piece of equipment.

4. Wet cure a minimum of 3 days, but not less than that recommended by the manufacturer.

    a. Epoxy Grout: Dry curing is acceptable if recommended by the manufacturer.

5. Use epoxy non-shrink grout under all machinery, pumps, equipment, and where chemicals are present that would abate cementitious non-shrink grouts.

3.10 CONCRETE PROTECTION AND CURING

A. General: Give careful attention to proper concrete curing. The curing methods shall be wet curing, sheet materials conforming to ASTM C171, or membrane curing compound conforming to ASTM C309. Membrane curing is not permitted on surfaces to be rubbed or on surfaces to which additional concrete, plaster mix mortar, or terrazzo is to be applied. Unless the curing method is specified otherwise, select the appropriate curing method.

B. Length of Curing Period:

1. A "curing day" shall be any day on which the atmospheric temperature taken in the shade, or the air temperature adjacent to the concrete, remains above 50 F for at least 18 hours.

2. Cure concrete for a period of 7 consecutive days. In cold weather, when curing may be retarded, extend this period to 7 "curing days", up to a limit of 14 consecutive days.

C. Wet Curing:

1. Immediately following the finishing operations, cover concrete slabs, including roof slabs, with wet cotton mats or with a temporary covering of canvas or burlap. Keep thoroughly wet for a period of 4 curing days after the concrete is placed. The covering shall be held in direct contact with the concrete. A temporary covering shall be required when the size of slab, size of mats, or other factors dictate that the mats cannot be placed immediately after the finishing operations without marring the finishing of the slab.

2. Water used for curing shall be free from injurious amounts of oil, acid, alkali, salt, or other deleterious substances.

3. Canvas or burlap covering material shall weigh not less than 12 ounces per square yard. Place the sections with a lap at the edges of at least 8 inches. Saturate cover material with water previous to placing. Keep saturated as long as it remains in place. Use care in the placing of the cover material to prevent marring the concrete surface.

4. When temporary coverings are used, keep them in place only until the slab has sufficiently hardened so that a cotton mat covering can be substituted without marring or disturbing the slab finish. Thoroughly saturate cotton mats before placing and keep the mats on the slab in a saturated condition for a period of at least 4 curing days.

D. Sheet Curing: Sheet materials shall conform to ASTM C171. They shall be in contact with the entire concrete surface and applied according to the manufacturer's recommendations. Patch all holes. Where pedestrian traffic is unavoidable, provide suitable walkways to protect the sheet material.

E. Membrane Curing:

1. Membrane curing shall not be used on surfaces which receive paint, floor hardener, or plaster mix finish or other finish which would be hindered by the use of the curing compound.

2. Cover the surface of the concrete with a continuous, uniform, water-impermeable coating.

3. Immediately after the removal of the side and end forms, apply a coating to the sides and ends of all concrete. Apply the solution under pressure with a spray nozzle so that the entire exposed surface is completely covered with a uniform film. The rate of application shall insure complete coverage, but the area covered shall not exceed 150 square feet per gallon of curing compound.

4. The coating shall be sufficiently transparent and free of permanent color to not result in a pronounced color change from that of the natural concrete at the conclusion of the curing period. The coating shall, however, contain a dye of color strength to render the film distinctively visible on the concrete for a period of at least 4 hours after application.

5. After application and under normal conditions, the curing compound shall be dry to touch within 1 hour and shall dry thoroughly and completely within 4 hours. When thoroughly dry, it shall provide a continuous flexible membrane free from cracks or pinholes and shall not disintegrate, check, peel, or crack during the required curing period.

6. If the seal is broken during the curing period, immediately repair it with additional sealing solution.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. After the tie rods are broken back or removed, thoroughly clean the holes to remove grease and loose particles. Patch holes with structural concrete repair material or non-shrink grout. After the holes are completely filled, strike off flush excess mortar and finish the surface to render the filled hole inconspicuous.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. If the surface of the concrete is bulged, uneven, or shows honeycombing or form marks, which in the Engineer's opinion cannot be repaired satisfactorily, remove and replace the entire section.
2. Patch honeycomb and minor defects in all concrete surfaces with structural concrete repair material. Cut back each defective area with a pneumatic chipping tool as deep as the defect extends, but in no case less than 1/2 inch. Prepare the existing concrete and apply repair material according to the manufacturer's recommendations. Finish the surface of the patches to match finish on surrounding concrete.
3. Immediately after form removal, cut out honeycombs, rock pockets, and voids to expose solid concrete but not less than 1-inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with repair material before bonding agent has dried.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.12 FIELD QUALITY CONTROL

A. Testing:

1. General:

a. Tests shall be required throughout the Work to monitor the quality of concrete. Samples shall be taken in accordance with ASTM C172.

b. The Engineer may waive these requirements on concrete placements of ten cubic yards or less. However, evidence shall be furnished showing a design mix which meets the Specifications.

c. Unless noted otherwise, testing of the materials, ready mix, transit mix, or central plant concrete will be by an independent testing agency. The independent testing agency will be approved by the Owner and paid by the Contractor. A summary of all tests performed will be available. No concrete shall be placed without a representative present at either the plant or at the Site.

d. Unless the Owner's laboratory is on the Site, provide housing for the curing and storage of test specimens and equipment.

2. Slump Test: Slump tests, in accordance with ASTM C143, shall be used to indicate the workability and consistency of the concrete mix from batch to batch. Generally, a slump test shall be made at the start of operations each day, at regular intervals throughout a working day, and at any time when the appearance of the concrete suggests a change in uniformity.

3. Air Content Test: Tests for the concrete's air content shall be made in accordance with ASTM C231 or ASTM C173, at the point of delivery of concrete, prior to placing in forms. The test shall be made frequently to monitor a proper air content uniform from batch to batch.

4. Temperature Test: Test for the concrete's temperature in accordance with ASTM C1064 and as follows: the temperature of the concrete to be placed shall be taken with a thermometer immediately before placement, with the point of measurement being in the chute or bucket. Temperature test shall be performed for each truck. Record temperatures on batch ticket.

5. Compression Test:

a. Compression test specimens shall be 6-by-12-inch concrete cylinders made and cured in accordance with ASTM C31. If the maximum aggregate size is no larger than 1 inch, 4-by-8-inch concrete cylinders are acceptable. No fewer than two 6-by-12-inch or three 4-by-8-inch specimens shall be made for each test Sample. Samples shall be taken at a minimum of every 50 cubic yards of concrete for each class placed. At least one set of test specimens per day shall be made for each class of concrete used that day. Specimens shall be cured under laboratory conditions specified in ASTM C31. Additional concrete cylinders may be required for curing on the job under actual job curing conditions. These Samples could be required when:

1). There is a possibility of the air temperature surrounding the concrete falling below 40 F, or rising above 90 F.

2). The curing procedure may need to be improved and/or lengthened.

3). It is necessary to determine when the structure may be put into service.

b. Compression strength tests shall be made on the laboratory-cured and job-cured concrete cylinders at 7 and 28 days, in accordance with ASTM C39. The value of each test result shall be the average compressive strength of all of the cylinders in the test Sample. All cylinders within a test Sample shall be taken at the same time from the same batch of concrete. For the 28-day cylinders, the strength level shall be satisfactory if the averages of all sets of three consecutive strength test results exceed the required design compressive strength, and no individual strength test result falls below the required compressive strength by more than 500 psi.

6. Failure to Meet Requirements:

a. Should the 7-day strengths shown by the test specimens fall below the required values, additional curing shall be performed on those portions of the structures represented by the test specimens at the Contractor's expense. Test cores shall be obtained and tested in accordance with ASTM Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, Designation C 42. If additional curing does not give the strength required, the Owner reserves the right to require strengthening, replacement of those substandard portions of the structure, or additional testing, at the Contractor's expense.

b. Upon receipt of the Contractor's written request, substandard concrete work may be reexamined in place by nondestructive testing methods or core Samples, in accordance with ACI 301. The services of an independent testing laboratory shall be retained and all expenses paid without compensation from the Owner. Laboratory results shall be evaluated by the Engineer, who shall make the final decision on acceptability of the concrete in question. Core Sample holes shall be repaired.

c. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

d. Nondestructive Testing: : Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

e. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Engineer.

B. The Owner may withhold payment for any section of concrete which does not meet the requirements of the Specifications. Withheld payment shall be based upon the unit prices established for concrete and reinforcing steel. Payment shall be withheld until the unacceptable concrete has been refinished, removed and replaced or otherwise brought into conformance with the Specifications.

C. PVC/TPER/PE Waterstops: Waterstops shall be observed by the Owner's representative prior to concrete placement. Unacceptable splicing defects include:

1. Misalignment of center bulb, ribs, and end bulbs greater than 1/16 inch.
2. Bond failure at joint deeper than 1/16 inch.
3. Misalignment which reduces waterstop cross-section more than 15 percent.
4. Bubble or visible porosity in the weld.
5. Visible signs of splice separation when a cooled splice is bent by hand at a sharp angle.
6. Charred or burnt material.

END OF SECTION

Concrete Mix Design

Project Name: _____

FNI Project Number: _____

Project Location: _____

Owner: _____

General Contractor: _____

Mix Number / Class: _____

A. Mix Design:

Cement	=	_____	lb/yd³
Fly Ash	=	_____	lb/yd³
Other Cementitious Material:			
_____	=	_____	lb/yd³
Fine Aggregate	=	_____	lb/yd³
Coarse Aggregate	=	_____	lb/yd³
Water	=	_____	lb/yd³
Water Reducing Admixture	=	_____	oz/yd³
High Range Water Reducer	=	_____	oz/yd³
Air Entraining Admixture	=	_____	oz/yd³
Other Admixture:			
_____	=	_____	oz/yd³
Slump	=	_____	inches
Gross Weight	=	_____	lb/yd³
Air Content	=	_____	percent
Water/Cement Ratio	=	_____	

B. Materials:

	Source	ASTM	Type	Remarks
Cement				
Fly Ash				
Other Cementitious Material: _____				
Fine Aggregate				
Coarse Aggregate				
Water				
Water Reducer				
High Range Water Reducer				
Air Entraining				

	Source	ASTM	Type	Remarks
Other Admixture: _____				

C. Determination of Average Strength Required (fcr'):

1. Test Records Available:

A. Summary of Test Records (Provide Supporting Documentation):

Test Group No.	No. of Consecutive Tests	Specified Strength (psi)	Standard Deviation (psi)
Average Standard Deviation:			

B. Standard Deviation Modification Factor (ACI 30 1, Table 4.2.3.3.a): ____.

C. Standard Deviation Used: ____.

D. Average Compressive Strength Required: ____.

2. Test Records Not Available:

A. Average Compressive Strength Required (ACI 30 1, Table 4.2.3.3.b, if required): ____.

D. Documentation of Required Average Compressive Strength (Check One):

1. Field Strength:

a. Field Strength Test Records (ACI 30 1, Table 4.2.3.3.a): ____. *Complete Attachment A.

2. Trial Mixtures:

a. Trial Mixtures (ACI 301, Table 4.2.3.3.b, if required): ____. *Complete Attachment B.

I, _____ certify that the above information is correct and all gradations, cement certifications, and test results are located at our place of business for review by the Engineer.

Name: _____ Date: _____

Title: _____

Company: _____

Address: _____

_____

_____

Attachment A

Documentation of Required Average Strength – Field Strength Records

(ACI 301, 4.2.3.4.a)

A. Summary of Test Records (Provide Supporting Documentation):

Test Record No.	No. of Tests in Record	Duration of Record (days)	Water-Cementitious Materials Ratio	Average Strength (psi)

B. Interpolation used? _____.

1. Provide an interpolation calculation or plot of strength versus proportions.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Source of each material used.
4. Amount of water.
5. Proportions of each aggregate material per cubic yard.
6. Gross weight per cubic yard.
7. Measured slump.
8. Measured air content.
9. Results of consecutive strength tests.

END OF ATTACHEMENT A

Attachment B

Documentation of Required Average Strength – Trial Mixtures

(ACI 301, 4.2.3.4.b)

A. Summary of Test Record(s):

Trial Mix No.	7-Day Tests		28-Day Tests		Water-Cementitious Materials Ratio	Slump (in)	Air Content (percent)	Temperature (F)
	No. of Test Cylinders	Strength (psi)	No. of Test Cylinders	Strength (psi)				

B. Maximum water-cementitious materials ratio _____.

1. Provide an interpolation calculation or plot of strength versus water-cementitious materials ratio.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Amount of water used in trial mixes.
4. Proportions of each aggregate material per cubic yard.
5. Gross weight per cubic yard.
6. Measured slump.
7. Measured air content.
8. Compressive strength developed at 7 days and 28 days, from not less than three test cylinders cast for each 7-day and 28-day test.

END OF ATTACHMENT B

03 40 16 PRECAST CONCRETE BUILDINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to install precast concrete buildings.

1.02 QUALITY ASSURANCE

A. Design Criteria: Each building shall be designed and constructed in accordance with the following design parameters:

1. Roof Live Load: 20 psf.
2. Wind Load: IBC 2015 and ASCE 7-10, Risk Category III.

B. Manufacturer's Representative: Provide the services of a manufacturer's representative in accordance with Section 01 75 00 "Starting and Adjusting."

C. Experience Requirements: The precast concrete building manufacturer shall have at least 5 years of successful experience in the design, manufacture, and erection of buildings of the type and size specified.

1. The manufacturer shall be a producer member of National Precast Concrete Association and/or Architectural Precast Association.
2. The manufacturer shall be one of the following
   a. Lonestar Prestress Mfg., Inc.
   b. Speed Fab-Crete.
   c. Approved equal.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Shop Drawings and engineering calculations signed and sealed by a professional engineer licensed in the state where the Project is located.
2. Operation and Maintenance Manuals.
3. Equipment Installation Report.

1.04 STANDARDS

A. Precast concrete buildings shall be designed and constructed in accordance with local, state and national codes that have jurisdiction or authority over the Work. If the standards and codes conflict with each other, the most stringent shall apply.

B. The applicable provisions of the following standards apply as if written here in their entirety:

1. American Concrete Institute (ACI): ACI 318, “Building Code Requirements for Structural Concrete and Commentary.”
2. American Society of Civil Engineers (ASCE): ASCE 7, “Minimum Design Loads and Associated Criteria for Buildings and Other Structures.”
3. Concrete Reinforcing Steel Institute (CRSI): Manual of Standard Practice.
4. International Code Council (ICC): IBC, “International Building Code.”

1.05 DELIVERY AND STORAGE

A. Building components shall be delivered to the Site along with all accessories and fasteners. Provide a means for unloading and handling at the job Site. If components are stored prior to erection, place on wood runners raised above ground level. Protect from damage.

2.00 PRODUCTS

2.01 MATERIALS

A. Fasteners and Anchoring:

1. 1/2-inch minimum diameter and/or studs.
2. Finish: Stainless steel, Type 304, Class 1 or Class 2.

B. Mounting Hardware:

1. 1/4-inch minimum thickness plate and/or members.
2. Finish: Stainless steel, Type 304**.**

C. Caulking: Sikaflex -1a, limestone, as manufactured by Sika Corporation or approved equal.

D. Reinforcing Steel: ASTM A615, Grade 60.

2.02 MIXES

A. Concrete: Steel reinforced, polypropylene fiber reinforced, 5000 psi minimum 28-day compressive strength, air entrained in accordance with ASTM C260.

2.03 FABRICATIONS

A. The building shall be precast concrete with scheduled dimensions, minimum 3-inch roof overhang on all sides, and minimum roof slope of 1/4- inch per foot.

1. Exterior walls shall have exposed aggregate finish. Interior walls shall have a smooth steel form finish.
2. The roof shall have a smooth trowel finish sealed with a clear waterproofing.

B. Panels shall be securely fastened together with brackets. Joints between panels shall be caulked on the exterior surface of the joints.

1. Precast concrete sandwich panels with extruded polystyrene core between concrete wythes.

a. Minimum Required Thermal Performance, R-Value: 7.5

b. Minimum Wythe Thickness: 2-inches.

C. The precast building shall be installed complete with foundation as shown on the Drawings. The foundation shall be cast-in-place by the Contractor. The manufacturer and Contractor shall coordinate all hardware to be cast into the slab.

D. The manufacturer shall furnish and install a wall-mounted exhaust fan of scheduled capacity, with insect screen, and have an adequately sized intake louver opposite from the fan.

E. Doors and frames shall comply with Steel Door Institute (SDI 100) "Recommended Specifications for Standard Steel Doors and Frames", and:

1. Finish: Door and frames shall be bonderized and painted with one coat of rust inhibitive primer.

2. Technical Specification 08 11 13 Hollow Metal Doors and Frames

F. Door hardware shall be vandal-proof. A deadbolt lockset with satin finish and matching keys shall be provided. Hinges shall be ball bearing with non-removable pins.

1. Finish: All hardware and bolts shall be stainless steel, Type 304.

2. Provide stainless steel hydraulic closure mechanism on each door. Equip one door of each pair with panic type hardware.

3. An aluminum threshold with neoprene insert shall be provided. Door stops for securing the doors full open shall be provided

G. Provide light fixtures as indicated on the Drawings.

H. All Work shall comply with the latest version of the National Electric Code and local ordinances.

1. Provide all electrical outlets and appurtenances indicated on the Drawings and required by the National Electric Code.

2. All electrical work shall comply with Division 26 Specifications:

a. Shall be completed under the direct supervision of a Master Electrician holding a current license in the state in which the Project is located.

3. Provide power distribution panel in the building with a main circuit breaker. Electrical system for the building shall be complete, with a single point of connection for the electrical service.

3.00 EXECUTION

3.01 PREPARATION

A. Shave all protruding polypropylene fibers flush with walls prior to painting. Paint interior walls in accordance with Section 09 96 00.01 "High-Performance Coatings."

3.02 INSTALLATION

A. Install the building in strict accordance with the manufacturer's recommendations and as shown on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Upon installation, the building shall be level to within 0.01 foot in each direction, and plumb to within 1/4 inch.

3.04 SCHEDULES

A. Buildings shall be furnished in accordance with the following schedule:

Building Name	Outside Dimensions (L X W x H)	Door No. & Dimensions	HVAC Capacity (cfm)	Electric Unit Heater Comments
Electrical Building	30' x 40' x 15'	100A - Pair 6.0' x 8.5' 100B – Single 3.0' x 7.0'	1900 cfm (supply) 25 cfm (outside)	NA

END OF SECTION

05 50 00 METAL FABRICATIONS

1.00 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Miscellaneous steel trim.
4. Metal bollards.
5. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections:

1. Section 03 30 00 “Cast-In-Place Concrete” for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 05 51 00 “Metal Stairs.”
3. Section 05 52 13 “Pipe and Tube Railings.”

1.02 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 F, ambient; 180 F, material surfaces.

1.03 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."

2. AWS D1.2, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.07 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

2.00 PRODUCTS

2.01 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A240 or ASTM A666, Type 316.

C. Stainless-Steel Bars and Shapes: ASTM A276, Type 316.

D. Steel Tubing: ASTM A500, cold-formed steel tubing.

E. Steel Pipe: ASTM A53, standard weight (Schedule 40) unless otherwise indicated.

F. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches or as required to comply with structural performance criteria.

2. Material: Galvanized steel, ASTM A653, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.

2.03 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

2.04 FASTENERS AND ANCHORS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.

2. Provide stainless-steel fasteners for fastening stainless steel.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.

C. Deformed Bar Anchor: ASTM A1064, AWS D1.1 Type C.

D. Anchor Rods: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Hot-dip galvanized or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: Chemical anchors.

1. Material: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

D. Anti-Seize Lubricant: Loctite LB 8023 Marine Grade Anti-Seize lubricant or approved equal.

2.06 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.07 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Section 09 96 00.01 “High-Performance Coatings” where indicated.

2.08 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize miscellaneous steel trim where indicated.

D. Prime miscellaneous steel trim with primer specified in Section 09 96 00.01 “High-Performance Coatings.”

2.09 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

B. Fabricate bollards with 3/4-inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Prime bollards with zinc-rich primer**.**

2.10 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates where indicated.

C. Prime plates with primer specified in Section 09 96 00.01 “High-Performance Coatings.”

2.11 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.12 FINISHES, GENERAL

A. Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153 for steel and iron hardware and with ASTM A123 for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Section 09 96 00.01 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.14 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.15 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

3.00 EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size

limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.

2. Extruded Aluminum: Two coats of clear lacquer.

G. Anti-Seize Lubricant: Where stainless steel nuts and bolts will be installed, apply anti-seize lubricant to threads as recommended by lubricant manufacturer to prevent seizure of nut and bolt during installation or upon removal at a future date.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.03 INSTALLING METAL BOLLARDS

A. Anchor bollards to existing construction with chemical anchors. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 6 inches in concrete, unless otherwise indicated.

B. Anchor bollards in place with concrete footings. Center and align bollards in holes three inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

C. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.04 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink, nonmetallic grout unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3. Moist cure grout for a minimum of 7 days.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage an approved qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's “Specification for Structural Joints Using ASTM A325 or A490 Bolts.”

C. Welded Connections: Field welds will be 100 percent visually inspected according to AWS D1.1.

1. Full penetration welds and other welds as specified: In addition to 100 percent visual inspection, 10 percent of connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E165.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection: ASTM E164.

d. Radiographic Inspection: ASTM E94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1. Corrective measures shall be taken when welding is unsatisfactory or indicates inferior workmanship. Chip and grind if the removal of part of the weld or a portion of the base metal is required. Where deposition of additional weld material is necessary, the sides of the area to be welded shall have no less than one to one (1:1) slope to allow room for depositing new material. Correct defective or unsound welds by the removal and replacement of the entire weld using the following procedures:

a. Excessive Convexity: Reduce to size by removal of excess weld metal by grinding.

b. Shrinkage Cracks, Cracks in Base Metal, Craters and Excessive Porosity: Remove defective portions of base and weld material down to sound metal, and deposit additional sound material.

c. Undercutting, Undersize, and Excessive Concavity: Clean and deposit additional weld metal.

d. Overlapping and Incomplete Fusion: Remove and replace the defective portion of the weld.

e. Slag Inclusion: Remove those parts of the welds containing slag. Fill with sound weld metal.

f. Removal of Adjacent Base Metal during Welding: Clean and form full size by depositing weld material.

2. Remove cracked welds throughout their length.

3. Where work performed subsequently to the making of the deficient weld has rendered the weld inaccessible, or has caused new conditions which make connection of the deficiency dangerous or ineffectual, restore the original conditions by removing welds or members, or both before making the necessary corrections. Another option is to compensate for the deficiency with additional work according to the revised design, approved by the Engineer.

4. Cut apart and reweld improperly fitted and misaligned parts.

5. Straighten members distorted by heat of welding using mechanical means or by carefully supervised application of a limited amount of localized heat. Heated areas shall not exceed 1200 degrees Fahrenheit as measured by Tempilsticks. Parts to be heated for straightening shall be free from external stress forces, except when mechanical means are used in conjunction with heat application.

6. If faulty welding or its removal for rewelding damages the base metal so that, in the Engineer's judgment, it is not in accordance with the intent of the Contract Documents, remove and replace the damaged material and compensate for the deficiency in a manner acceptable to the Engineer.

7. Maximum space between pieces or members for fillet welds shall be 1/16 inch. Only effective portion shall be considered in measuring fillet welds.

3.06 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00.01 “High-Performance Coatings.”

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION

05 51 00 METAL STAIRS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Industrial-type stairs with aluminum grating treads.
2. Aluminum pipe and tube railings attached to metal stairs.
3. Aluminum pipe and tube handrails attached to walls adjacent to metal stairs.

B. Related Sections:

1. Section 05 52 13 “Pipe and Tube Railings” for pipe and tube railings not attached to metal stairs or to walls adjacent to metal stairs.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/240 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:
    a. Uniform load of 50 lbf/ ft. applied in any direction.
    b. Concentrated load of 200 lbf applied in any direction.
    c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
    a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b. Infill load and other loads need not be assumed to act concurrently.

1.04 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Abrasive nosings.

2. Grout.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For the following products, in manufacturer's standard sizes:

1. Grating treads.

2. Abrasive nosings.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.

1. Test railings according ASTM E894 and ASTM E935.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Industrial-Type Stairs: Industrial class.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."

1.07 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

2.00 PRODUCTS

2.01 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 NONFERROUS METALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

B. Aluminum Castings: ASTM B26, Alloy 443.0-F.

2.03 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast aluminum, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Safety Tread Co., Inc.

b. Balco Inc.

c. Barry Pattern & Foundry Co., Inc.

d. Granite State Casting Co.

e. Safe-T-Metal Company, Inc.

f. Wooster Products Inc.

2. Configuration: Cross-hatched angle-shaped units, same depth as bar-grating treads and 1 to 1-1/2 inches wide.

2.04 FASTENERS

A. General: Provide Type 316 stainless steel fasteners. Select fasteners for type, grade, and class required.

B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Material: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

C. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.07 ALUMINUM-FRAMED STAIRS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alfab, Inc.
2. American Stair, Inc.

3. Sharon Companies Ltd. (The).

B. Stair Framing:

1. Fabricate stringers of aluminum channels.

a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of aluminum channel headers and miscellaneous framing members as needed to comply with performance requirements.

3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded or pressure-locked aluminum grating with openings in gratings no more than 3/4 inch in least dimension.

2. Surface: Serrated.

3. Finish: Mill finish.

4. Fabricate grating treads with cast abrasive nosing and with aluminum angle or plate carrier at each end for stringer connections. Secure treads to stringers with bolts.

5. Fabricate grating platforms with nosing matching that on grating treads. Provide toe plates at open-sided edges of grating platforms. Fasten grating to platform framing.

2.08 STAIR RAILINGS

A. Comply with applicable requirements in Section 05 52 13 "Pipe and Tube Railings."

2.09 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

3.00 EXECUTION

3.01 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Field Welding: Comply with requirements for welding in “Fabrication, General” Article.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASE PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of base plates.

B. Set aluminum stair base plates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use non-metallic, non-shrink grout unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to aluminum by bolting or welding directly to aluminum supporting members.

END OF SECTION

05 52 13 PIPE AND TUBE RAILINGS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Aluminum pipe and tube railings.

1.03 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project Site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
    a. Show method of connecting and finishing members at intersections.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E894 and ASTM E935.

C. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code - Aluminum."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.08 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum Pipe and Tube Railings:

1. ATR Technologies, Inc.
2. Blum, Julius & Co., Inc.
3. Braun, J. G., Company; the Wagner Companies
4. CraneVeyor Corp.
5. Hollaender Manufacturing Company
6. Kee Industrial Products, Inc.
7. Moultrie Manufacturing Corporation
8. Sterling Dula Architectural Products, Inc. / Kane Sterling
9. Superior Aluminum Products, Inc.
10. Thompson Fabricating, LLC
11. Tri Tech, Inc.
12. Tubular Specialties Manufacturing, Inc.
13. Tuttle Railing Systems
14. Wagner, R & B, Inc.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed and Registered in the State of Texas, to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.

b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F.

2.03 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.04 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B221, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tubing: ASTM B429, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

D. Drawn Seamless Tubing: ASTM B210, Alloy 6063-T832.

E. Plate and Sheet: ASTM B209, Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

G. Castings: ASTM B26, Alloy A356.0-T6.

2.05 FASTENERS

A. General: Provide the following:

1. Aluminum Railings: Type 316 stainless-steel fasteners.

2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Material: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

2.06 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

C. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project Site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.07 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.

H. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

J. Form Changes in Direction as Follows:

    1. By bending or by inserting prefabricated elbow fittings.

K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

P. For railing posts set in concrete, provide sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

Q. For removable railing posts, fabricate slip-fit sockets from tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.08 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41.

3.00 EXECUTION

3.01 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in “Fabrication” Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.03 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Cover anchorage joint with flange of same metal as post, attached to post with set screws.

C. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.

E. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.04 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.

C. Attach railings to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.

3.05 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.06 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

08 11 13 HOLLOW METAL DOORS AND FRAMES

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

B. Related Sections:

1. Division 03 Section "Precast Concrete Buildings" for embedding anchors for hollow metal work into concrete construction.
2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
3. Division 09 Sections "Painting" for field painting hollow metal doors and frames.

1.03 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to finish of factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.08 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld Building Products, LLC.
2. Benchmark; a division of Therma-Tru Corporation.
3. Ceco Door Products; an Assa Abloy Group company.
4. Curries Company; an Assa Abloy Group company.
5. Deansteel Manufacturing Company, Inc.
6. Firedoor Corporation.
7. Fleming Door Products Ltd.; an Assa Abloy Group company.
8. Habersham Metal Products Company.
9. Kewanee Corporation (The).
10. Mesker Door Inc.
11. Pioneer Industries, Inc.

12. Security Metal Products Corp.
13. Steelcraft; an Ingersoll-Rand company.

2.02 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.03 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard polyurethane or polyisocyanurate, core.
    a. Thermal-Rated (Insulated) Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) when tested according to ASTM C 1363.
        1) Locations: Exterior doors.
3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.04 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.05 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:
   a. Two anchors per jamb up to 60 inches (1524 mm) high.
   b. Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
   c. Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
   d. Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.06 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly

at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
4. Jamb Anchors: Provide number and spacing of anchors as follows:
    a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
        1) Two anchors per jamb up to 60 inches (1524 mm) high.
        2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
        3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
5. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.

3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.07 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   b. Install frames with removable glazing stops located on secure side of opening.
   c. Install door silencers in frames before grouting.
   d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   f. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:
   a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
   b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
   c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).

d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

3.04 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

08 31 19 FLOOR ACCESS DOORS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install access doors as indicated on the Drawings or specified herein.

1.02 QUALITY ASSURANCE/ACCEPTABLE MANUFACTURERS:

A. Products that comply with the Specifications by the following manufacturers will be acceptable:

1. U.S.F. Fabrication.
2. Halliday Products.
3. East Jordan Iron Works.
4. Bilco.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings.
2. Operation and Maintenance Manuals.
3. Manufacturer shall provide structural calculations showing that the door design is rated for a minimum of 320 P.S.F. with a maximum deflection of 1/150th of the span.

1.04 DELIVERY AND STORAGE

A. Ship products in protective wood crates. Leave in crates until ready to install. Store on wood platform raised 6 inches above surrounding grade and protect with weather resistant covering.

1.05 JOB CONDITIONS

A. Floor access door frames shall be set into forms as concrete is placed. Be sure that frames are set and braced to prevent movement during placement of concrete.

1.06 GUARANTEES AND WARRANTY

A. Manufacturer shall warrant that the complete system shall be free from defective material and workmanship for a minimum period of 5 years from date of Owner acceptance. The warranty shall be provided in writing starting from the date of acceptance by the Owner.

2.00 PRODUCTS

2.01 FLOOR ACCESS DOOR FOR PEDESTRIAN LOADING (300 PSF)

A. Door leaf shall be minimum 1/4-inch aluminum diamond pattern reinforced to support a minimum live load of 300 psf with a maximum deflection of 1/150th of the span.

B. The frame shall be extruded aluminum with anchor flange around the perimeter.

C. Door shall have sufficient number of compression spring operators to ensure that 15 lb. or less pull is required to open any single door leaf, and an automatic hold-open arm release handle.

D. The opening arm for the door leaf shall be lockable with a standard pad lock to control unauthorized entry.

E. Doors shall be outfitted with hold open arms to keep the covers in their upright, open positions.

F. Doors shall be outfitted with a recessed lifting handle.

G. All hardware shall be Type 316 stainless steel.

H. Bituminous coating shall be applied to the surfaces in contact with concrete.

I. Door shall be outfitted with nut rail on all four sides for attaching hardware.

J. Door shall be outfitted with aluminum skirting that makes the overall height of the frame equal to the top slab thickness, for casting into concrete.

K. Provide a notch in the leaf plating sized per pump manufacturer's recommendation to allow the submersible pump cable to penetrate to the surface. Provide rubber grommet along the cut edge of the hatch leaf to prevent wear on the cables penetrating the opening. Reference drawings for size and location.

2.02 SAFETY NET SYSTEM

A. Provide polyester safety net that anchors to the frame with stainless steel hardware.

B. Safety net system shall comply with OSHA Standard 1926.502, Drop Test.

2.03 SAFETY GRATE SYSTEM

A. Provide aluminum safety grate rated at 300 psf.

B. The safety grate shall be powder coated safety orange color. The coating shall be a minimum thickness of 4 mils and be shop applied and cured per manufacturer recommendations.

C. Grate openings shall be a minimum of 4 inches by 6 inches to allow for visual inspection, limited maintenance, and other adjustments while the safety grate is left in place. All hardware including hinges shall be stainless steel.

D. All hardware including hinges shall be stainless steel.

E. For H20-44 hatches, the safety grate system shall not bear any loading from the leaf above.

3.00 EXECUTION

3.01 FLOOR ACCESS DOOR INSTALLATION

A. Floor access doors and frames shall be installed in accordance with manufacturer's written instructions. Access door frames shall be cast into concrete structures. Concrete shall be worked around frame to ensure complete embedment of anchors. Frame shall be secured to prevent movement during placement of concrete. Frames shall be level.

B. Provide copper or PVC drains as necessary for access doors with integral drains. Connect drain piping to drain outlet of channel frame and extend to nearest wall of the structure. Drain shall not be routed across any access ladders or floor walking surfaces.

C. Floor access door frames shall be set level within 3/32 inch across diagonal corners, unless floor slab is designed to be out of level, then the access door shall be set to same place as floor slab.

D. Aluminum access door frames in contact with concrete shall be given a heavy coat of bituminous paint prior to installation.

E. For non-occasional traffic loaded hatches (H20-44), the allen-head bolts must be tightened to 25 foot pounds of torque and securely fastened using Loctite 242 whenever the cover is closed.

3.02 SCHEDULE

A. Floor access doors shall be supplied in accordance with the following schedule. The required doors and certain pertinent data is given below. This list is given to facilitate description of the various doors and as an aid to plan take off and is not guaranteed to be complete.

No.	Hatch Location	Length	Width	Hatch Loading	Leaf Construction*	Frame	Fall Protection
1	Colliers RWPS Top Slab – Submersible Pump 01 Access	7 ft	5 ft	Pedestrian	Double Door	Angle	Safety Grate
2	Colliers RWPS Top Slab – Submersible Pump 02 Access	7 ft	5 ft	Pedestrian	Double Door	Angle	Safety Grate
3	Colliers RWPS Top Slab – Submersible Pump 03 Access	7 ft	5 ft	Pedestrian	Double Door	Angle	Safety Grate
4	Colliers RWPS Top Slab – Submersible Pump 04 Access	7 ft	5 ft	Pedestrian	Double Door	Angle	Safety Grate
5	Colliers RWPS Top Slab – Instrumentation Access Hatch	2 ft	2 ft	Pedestrian	Single	Angle	Safety Grate
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

*Double door hatches shall have both sets of hinges on the opposite sides of the frame. Double leaf hatches shall have both sets of hinges on the same side of the frame.

END OF SECTION

08 71 00 DOOR HARDWARE

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:

a. Swinging doors.

B. Related Sections:

1. Section 08 11 13 “Hollow Metal Doors and Frames” for door silencers provided as part of hollow-metal frames.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

c. Content: Include the following information:

1). Identification number, location, hand, fire rating, size, and material of each door and frame.

2). Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

3). Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

4). Fastenings and other pertinent information.

5). Explanation of abbreviations, symbols, and codes contained in schedule.

6). Mounting locations for door hardware.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.

B. Source Limitations: Obtain each type of door hardware from a single manufacturer.

C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

2. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Inspect and discuss preparatory work performed by other trades.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

Deliver keys and permanent cores to Owner by registered mail or overnight package service.

C. COORDINATION

1. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
2. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of doors and door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty Period: 3 years from date of Substantial Completion, unless otherwise indicated.
      a. Exit Devices: 2 years from date of Substantial Completion.
      b. Closers: 10 years from date of Substantial Completion.

1.08 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, provide 6 months' full maintenance by skilled employees of door hardware Installer. Include repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

2.00 PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names may be abbreviated in Part 3 "Door Hardware Schedule" Article.

2.02 CONTINUOUS HINGES

A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch (3.0-mm) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bommer Industries, Inc.

b. Cal-Royal Products, Inc.

c. Hager Companies.

d. IVES Hardware; an Ingersoll-Rand company.

e. McKinney Products Company; an ASSA ABLOY Group company.

f. Select Products Limited.

g. Stanley Commercial Hardware; Div. of The Stanley Works.

h. Zero International.

2.03 HINGES

A. Manufacturer:

1. Listed in Door Hardware Schedule: Ives

2. Approved Substitutions: Per 1.06-A-2.

B. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template produced units.

C. Screws: Furnish Phillips flat head or machine screws for installation of units, except furnish Phillips flat head or wood screws for installation of units into wood. Finish screw heads to match surface of hinges.

D. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

1. Steel Hinges: Steel pins.

2. Non-ferrous Hinges: Stainless steel pins.

3. Exterior doors: Non-removable pins.

4. Reverse bevel interior doors (lockable): Non-removable pins.
5. Interior doors: Non-rising pins.

E. Pin Tips: Flat button and matching plug, finished to match leaves.

F. Number of Hinges: Provide number of hinges indicated, but not less than 3 hinges per door leaf for doors 90" or less in height and one additional hinge for each 30" of additional height.

G. Butt type hinges and continuous hinges are to be warranted for a period of two years. Pivots shall be warranted for a period of two years.

2.04 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
3. Deadbolts: Minimum 1.25-inch (32-mm) bolt throw.

C. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

1. Levers: Cast.
2. Escutcheons (Roses): Cast.
3. Dummy Trim: Match lever lock trim and escutcheons.
4. Operating Device: Lever with escutcheons (roses).

D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

E. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with stainless steel or brass parts; Series 1000.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:
    a. Accurate Lock & Hardware Co.
    b. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
    c. Arrow USA; an ASSA ABLOY Group company.
    d. Best Access Systems; Div. of Stanley Security Solutions, Inc.

e. Falcon Products.

f. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.

g. PDQ Manufacturing.

h. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

i. Schlage Commercial Lock Division; an Ingersoll-Rand company.

j. Yale Security Inc.; an ASSA ABLOY Group company.

2.05 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

a. Burns Manufacturing Incorporated.

b. Don-Jo Mfg., Inc.

c. Door Controls International, Inc.

d. IVES Hardware; an Ingersoll-Rand company.

e. Trimco.

2.06 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices: BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.

b. Arrow USA; an ASSA ABLOY Group company.

c. Falcon Products.

d. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.

e. DORMA Architectural Hardware; Member of The DORMA Group North America.

f. Dor-O-Matic; an Ingersoll-Rand company.

g. K2 Commercial Hardware; a Black & Decker Corp. company.

h. Precision Hardware, Inc.; Division of Stanley Security Solutions, Inc.

i. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

j. Von Duprin; an Ingersoll-Rand company.

k. Yale Security Inc.; an ASSA ABLOY Group company.

2.07 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass, bronze or stainless steel. All internal components of material suitable for a corrosive environment.
    1. Manufacturer: Same manufacturer as for locking devices.
    2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Arrow USA; an ASSA ABLOY Group company.
        b. ASSA, Inc.; An ASSA ABLOY Group Company.
        c. Falcon Products.
        d. Best Access Systems; Div. of Stanley Security Solutions, Inc.
        e. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
        f. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
        g. Schlage Commercial Lock Division; an Ingersoll-Rand company.
        h. Yale Security Inc.; an ASSA ABLOY Group company.
B. High-Security Lock Cylinders: BHMA A156.30; Grade 1; Type M, mechanical; permanent cores that are removable; face finished to match lockset.
C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 5 construction master keys.

2.08 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference. Match Owner's existing keying system.
    1. Existing System:
        a. Master key or grand master key locks to Owner's existing system.
    2. Keyed Alike: Key all cylinders to same change key.
B. Keys: Brass.
    1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
        a. Notation: Information to be furnished by Owner.
    2. Quantity: In addition to one extra key blank for each lock, provide the following:
        a. Cylinder Change Keys: Three.
        b. Master Keys: Five.

2.09 OPERATING TRIM

A. Operating Trim: BHMA A156.6; aluminum or stainless steel, unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Burns Manufacturing Incorporated.
    b. Don-Jo Mfg., Inc.
    c. Forms + Surfaces.
    d. Hager Companies.
    e. Hiawatha, Inc.
    f. IVES Hardware; an Ingersoll-Rand company.
    g. Rockwood Manufacturing Company.
    h. Trimco.

2.10 ACCESSORIES FOR PAIRS OF DOORS

A. Astragals: BHMA A156.22.

2.11 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Arrow USA; an ASSA ABLOY Group company.
        b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
        c. DORMA Architectural Hardware; Member of The DORMA Group North America.
        d. Dor-O-Matic; an Ingersoll-Rand company.
        e. Falcon Products.
        f. K2 Commercial Hardware; a Black & Decker Corp. company.
        g. LCN Closers; an Ingersoll-Rand company.
        h. Norton Door Controls; an ASSA ABLOY Group company.
        i. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
        j. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
        k. Yale Security Inc.; an ASSA ABLOY Group company.

2.12 MECHANICAL STOPS AND HOLDERS

A. Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Builders Hardware Mfg., Inc.

b. Baldwin Hardware Corporation.

c. Burns Manufacturing Incorporated.

d. Cal-Royal Products, Inc.

e. Don-Jo Mfg., Inc.

f. Door Controls International, Inc.

g. Hager Companies.

h. Hiawatha, Inc.

i. IVES Hardware; an Ingersoll-Rand company.

j. Rockwood Manufacturing Company.

k. Stanley Commercial Hardware; Div. of The Stanley Works.

l. Trimco.

2.13 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.

b. M-D Building Products, Inc.

c. National Guard Products.

d. Pemko Manufacturing Co.; an ASSA ABLOY Group company.

e. Reese Enterprises, Inc.

f. Sealeze; a unit of Jason Incorporated.

g. Zero International.

2.14 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hager Companies.
    b. M-D Building Products, Inc.
    c. National Guard Products.
    d. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
    e. Reese Enterprises, Inc.
    f. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
    g. Sealeze; a unit of Jason Incorporated.
    h. Zero International.

2.15 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch (1.3-mm) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:
        a. Baldwin Hardware Corporation.
        b. Burns Manufacturing Incorporated.
        c. Don-Jo Mfg., Inc.
        d. Hiawatha, Inc.
        e. IPC Door and Wall Protection Systems, Inc.; Div. of InPro Corporation.
        f. IVES Hardware; an Ingersoll-Rand company.
        g. Pawling Corporation.
        h. Rockwood Manufacturing Company.
        i. Trimco.
        j. Hager Companies.

2.16 FABRICATION

A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with

commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Fire-Rated Applications:
    a. Wood or Machine Screws: For the following:
        1). Strike plates to frames.
    b. Steel Through Bolts: For the following unless door blocking is provided:
        1). Surface hinges to doors.
        2). Closers to doors and frames.
        3). Surface-mounted exit devices.
2. Spacers or Sex Bolts: For through bolting of FRP doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.17 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights unless otherwise indicated or required to comply with governing regulations.
    1. DHI's recommendations.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of

surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

D. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of asphaltic emulsion.

E. Stops: Provide floor stops for doors unless other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

G. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.04 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

Door Hardware Set No.1
Door Number: 100A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112HD/224HD HEIGHT AS REQ	628	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB HEIGHT AS REQ	689	VON
1	EA	PANIC HARDWARE	LD-99-EO LENGTH AS REQ	626	VON
1	EA	PANIC HARDWARE	LD-99-NL-SNB	626	VON
1	EA	SFIC EVEREST CORE	MATCH STANDARD	626	SCH
1	EA	MORTISE CYL	MATCH STANDARD	626	SCH
2	EA	SURFACE CLOSER	4050A SCUSH X MTNG BRCK, SPACER, PLATE AS REQ TO SUIT CONDITIONS	695	LCN
1	EA	KICK PLATE	8400 10” X 2” LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	MEETING STILE	328AA (2 PCS - 1 SET) HEIGHT AS REQUIRED (OMIT @ NON-RATED DOORS)	AA	ZER
2	EA	DOOR SWEEP	8198AA LENGTH AS REQ	AA	ZER
1	EA	THRESHOLD	65A LENGTH AS REQ	A	ZER
2	EA	MULLION SEAL	8780N HEIGHT AS REQ	BK	ZER

Door Hardware Set No.2
Door Number: 100B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD/224HD HEIGHT AS REQ	628	IVE
1	EA	PANIC HARDWARE	99-L-06	626	VON
1	EA	SFIC EVEREST CORE	MATCH STANDARD	626	SCH
1	EA	RIM CYLINDER	MATCH STANDARD	626	SCH
1	EA	SURFACE CLOSER	4050A SCUSH X MTNG BRCK, SPACER, PLATE AS REQ TO SUIT CONDITIONS	695	LCN
1	EA	KICK PLATE	8400 10” X 2” LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA LENGTH AS REQ	AA	ZER
1	EA	THRESHOLD	65A LENGTH AS REQ	A	ZER

END OF SECTION

09 91 00 PAINTING

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color or finish is not indicated, Architect will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Finished mechanical and electrical equipment.

b. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Utility tunnels.

b. Duct shafts.

3. Finished metal surfaces include the following:

a. Anodized aluminum.

b. Stainless steel.

c. Galvanized metal

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.

b. Linkages.

c. Sensing devices.

d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.

2. Division 9 Section "High Performance Coatings" for industrial paints and maintenance and for special coatings.

1.03 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.

2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.

3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.

4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.04 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

3. Manufactures standard color selection chart or packet of color chips.

B. Samples for Initial Selection: For each type of finish-coat material indicated.

1. After color selection, Architect will return selected color chips for surfaces to be coated.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.07 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F (10 and 32 deg C).

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F (7 and 35 deg C).

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Benjamin Moore & Co. (Benjamin Moore).
2. Coronado Paint Company (Coronado).
3. ICI Dulux Paint Centers (ICI Dulux Paints).
4. Kelly-Moore Paint Co. (Kelly-Moore).
5. PPG Industries, Inc. (Pittsburgh Paints).
6. Sherwin-Williams Co. (Sherwin-Williams).

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: As selected by Architect from manufacturer's full range.

2.03 CONCRETE UNIT MASONRY BLOCK FILLERS

A. Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.

1. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils (0.206 mm).

2. Benjamin Moore; Moore's IMC Latex Block Filler No. M88: Applied at a dry film thickness of not less than 8.1 mils (0.206 mm).

3. Coronado; 946-11 Super Kote 5000 Commercial Latex Block Filler: Applied at a dry film thickness of not less than 8.4 mils (0.214 mm).

4. ICI Dulux Paints; Bloxfil 4000-1000 Interior/Exterior Heavy Duty Acrylic Block Filler: Applied at a dry film thickness of not less than 7.0 to 14.5 mils (0.178 to 0.368 mm).

5. Kelly-Moore; 521 Fill and Prime Acrylic Block Filler: Applied at a dry film thickness of not less than 10.0 mils (0.254 mm).

6. M. A. B. Paint; Block Kote No. 1000 Acrylic Latex Block Filler 064-145: Applied at a dry film thickness of not less than 12.0 mils (0.305 mm).

7. Pittsburgh Paints; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils (0.152 to 0.318 mm).

8. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils (0.203 mm).

2.04 EXTERIOR PRIMERS

A. Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.

1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

2. Coronado; 35-147 Rust Scat Alkyd Metal Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

3. ICI Dulux Paints; 4160-XXXX Devguard Multi-Purpose Tank & Structural Primer. Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
4. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5. Kelly-Moore; 5725 DTM-Acrylic Metal Primer: Applied at a dry film thickness of not less than 1.8 mils (0.048 mm).
6. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
7. Pittsburgh Paints; 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
8. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

2.05 INTERIOR PRIMERS

A. Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.
   1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils (0.030 mm).
   2. Coronado; 40-11 Super Kote 5000 Latex Primer-Sealer: Applied at a dry film thickness of not less than 1.2 mils (0.030 mm).
   3. ICI Dulux Paints; 3030-1200 Bond-Prep Interior/Exterior Waterborne Pigmented Bonding Primer: Applied at a dry film thickness of not less than 1.8 mils (0.046 mm).
   4. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
   5. M. A. B. Paint; Fresh Kote Vinyl Primer 037-100: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
   6. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
   7. Sherwin-Williams; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

B. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.
   1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
   2. Coronado; 35-147 Rust Scat Alkyd Metal Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
   3. ICI Dulux Paints; 4130-6130 Devshield Rust Penetrating Metal Primer: Applied at a dry film thickness of not less than 2.2 mils (0.056 mm).
   4. ICI Dulux Paints; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

5. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
6. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
7. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
8. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

2.06 EXTERIOR FINISH COATS

A. Exterior Full-Gloss Alkyd Enamel: Factory-formulated full-gloss alkyd enamel for exterior application.
1. Benjamin Moore; Moore's IMC Urethane Alkyd Enamel M22: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
2. Coronado; 1223 Line Super Kote 5000 High Gloss Alkyd Enamel: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
3. ICI Dulux Paints; 4308-XXXX Devguard Alkyd Industrial Gloss Enamel: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
4. Kelly-Moore; 1700 Kel-Guard Gloss Alkyd Rust Inhibitive Enamel: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5. M. A. B. Paint; Rust-O-Lastic Finish Coating 074 Line: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
6. Pittsburgh Paints; 7-814 Pittsburgh Paints Industrial Gloss-Oil Interior/Exterior Enamel: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
7. Sherwin-Williams; Industrial Enamel B-54 Series: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

2.07 INTERIOR FINISH COATS

A. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
2. Coronado; 30-Line Super Kote 5000 Latex Eggshell Enamel: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
3. ICI Dulux Paints; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
4. Kelly-Moore; 1610 Sat-N-Sheen Interior Latex Low Sheen Wall and Trim Finish: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
5. Kelly-Moore; 1686 Dura-Poxy Eggshell Acrylic Enamel: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

6. M. A. B. Paint; Fresh Kote Latex Satin Eggshell Enamel 405 Line: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
7. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils (0.032 mm).
8. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

B. Interior Semigloss Alkyd Enamel: Factory-formulated semigloss alkyd enamel for interior application.

1. Benjamin Moore; Moorcraft Super Spec Alkyd Semi-Gloss Enamel No. 271: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2. Coronado; 27-Line Super Kote 5000 Alkyd Semi-Gloss Enamel: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
3. ICI Dulux Paints; 1516-XXXX Ultra-Hide Alkyd Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).
4. Kelly-Moore; 1630--Kel-Cote Interior Alkyd Semi-Gloss Enamel: Applied at a dry film thickness of not less than 2.2 mils (0.056 mm).
5. M. A. B. Paint; Fresh Kote Semi-Gloss 403 Line: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
6. Pittsburgh Paints; 6-1110 Series SpeedHide Interior Enamel Wall & Trim Semi-Gloss Oil: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
7. Sherwin-Williams; ProMar 200 Interior Alkyd Semi-Gloss Enamel B34W200 Series: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).

3.00 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.

2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Repair factory finish of doors on tops, bottoms, and side edges the same as faces.
9. Sand lightly between each succeeding coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items indicated on drawings and as listed below.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.

2. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.

3. Mechanical equipment that is indicated for field painting.

G. Electrical items to be painted include, but are not limited to, the following:

1. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.04 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.05 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.06 EXTERIOR PAINT SCHEDULE

A. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.

1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a rust-inhibitive primer.

a. Primer: Exterior ferrous-metal primer.

b. Finish Coats: Exterior full-gloss alkyd enamel.

3.07 INTERIOR PAINT SCHEDULE

A. Concrete Unit Masonry (Other than integral color Concrete Masonry Units): Provide the following finish systems over interior concrete masonry:

1. Low Luster Acrylic Finish: Two finish coats over a block filler.

a. Block Filler: Concrete unit masonry block filler.

b. Finish Coats: Interior flat acrylic paint.

B. Ferrous Metal: Provide the following finish systems over ferrous metal:

1. Semigloss Alkyd-Enamel Finish: Two finish coats over a primer.

a. Primer: Interior ferrous-metal primer.

b. Finish Coats: Interior semigloss alkyd enamel.

C. All-Service Jacket over Insulation: Provide the following finish system on cotton or canvas insulation covering:

1. Flat Acrylic Finish: Two finish coats. Add fungicidal agent to render fabric mildew proof.

a. Finish Coats: Interior flat latex-emulsion.

END OF SECTION

09 96 00.01 HIGH-PERFORMANCE COATINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to apply protective coatings to material and equipment as specified herein, including the preparation of surfaces prior to application of coatings.

B. Protective coatings are special coatings to be used at specific locations or on specific surfaces as indicated herein and are complementary to the coating surfaces specified in Section 09 91 00 “Painting” in that every surface of every description, except those which are specifically noted not to receive a coating finish, must be covered by a paint system as specified in this Section or in Section 09 91 00 “Painting.”

C. Protective coatings must be applied to the following surfaces:

1. Metal surfaces located outside of buildings and other structures anywhere on the Site.
2. New piping and valves, including**:**
    a. Aboveground pump discharge piping at the Raw Water Pump Station
    b. Pump discharge piping inside the wet well
    c. Aboveground meter run piping

D. The following must not be coated and must be protected from drips, overspray, etc. unless indicated otherwise

1. Stainless steel piping, materials and equipment
2. Galvanized steel piping, materials and equipment unless specifically indicated to be coated.
3. Aluminum materials and equipment
4. Interior electrical items

E. Special applications for painting include the following:

1. Aluminum surfaces in contact with or embedded in concrete must be treated in accordance with Section 03 30 00 “Cast-In-Place Concrete.”
2. Buried pipe and valves must receive a shop applied protective coating as described in the appropriate Section of the Specifications.

F. Contain, treat, and dispose of any dust, spray, drainage, or spillage resulting from coating operations. It is the Contractor’s responsibility to determine if the materials to be disposed of are classified as Hazardous Waste. Disposed of waste, hazardous or otherwise, must be in accordance with applicable regulations. Contractor must be aware of and understand the regulations concerning disposal of waste generated by coating operations.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers: Products which comply with the Contract Documents and are manufactured by the following companies will be acceptable:

1. Tnemec Company, Inc.
2. Carboline.
3. PPG Protective & Marine Coatings.
4. The Sherwin-Williams Company.
5. Akzo Nobel / International Paint, LLC.
6. ICI Devoe High Performance Coatings.
7. Plasite Protective Coatings.

It is desired that the paint products be furnished by as few manufacturers as possible to meet the requirements of the Specifications. Coating products of the same type must be supplied by the same manufacturer. Do not mix products from different sources.

B. Applicator's Qualifications: Applicators must be qualified in this line of work and have a minimum of 5 years of experience in the application of the protective coatings of the types specified herein. Submit a list of recent projects and names of references for those projects.

C. Product Quality:

1. Use only the coatings specified in this Section. Use only those thinners and solvents recommended by the manufacturer, only in the amounts necessary to produce the manufacturer's recommended spreading rate, and in amounts not exceeding the maximum quantities stated in the manufacturer's literature.
2. The coating material must not show excessive settling in a freshly opened full can and must be easily re-dispersed with a paddle to a smooth, homogeneous state. It must show no curdling, livering, caking, or color separation and must be free of lumps or skim surfaces.

D. Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
3. Perform Work only in the presence of Engineer, unless Engineer grants prior approval to perform such Work in Engineer's absence. Approval to perform Work in the Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the work day.
4. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, must not be construed to relieve the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

5. Contractor is solely responsible for testing for this Section, at no further cost to the Owner. Engineer may also make such tests if it is considered necessary. Cooperate with the Engineer, providing equipment, scaffolds, and other equipment as requested by the Engineer.

E. Testing Equipment: Furnish the testing apparatus necessary for testing coatings, including the following:

1. One set of U.S. Department of Commerce thickness calibration plates, certified by the National Bureau of Standards, to test dry film thickness.
2. Wet-film thickness gauges. Give one to Owner's representative. Each painter must keep one to test paint as it is applied.
3. One electronic dry-film thickness gauge capable or measuring 0-200 mils with calibration standards approved by the Bureau of Standards.
4. One Elcometer 319 Dewpoint Meter or approved equal.
5. One Tinker and Rasor Model M 1 Holiday Detector and recommended wetting agent and/or High Voltage Holiday Detector if required for coating thickness specified.
6. One set of SSPC-VIS 1**,** 3 and 4 **-** Visual Standards as applicable.

F. Testing Reports: Submit an inspection report for each coating applied on the Project. The testing report must be completed on a form furnished by the Engineer and must bear the signature of the Contractor and the Owner's representative.

G. The Contractor must schedule a construction conference prior to any field work being completed. The meeting will be at the Site and will include the Owner, Contractor, painting superintendent, Engineer, Owner's representative and coating manufacturer's representative. At this meeting the coating plan and schedule will be reviewed in detail.

1.03 SUBMITTALS

A. Submittals must be in accordance with Section 01 33 00 "Document Management."

B. The following Product Data for products, including manufacturer's data sheets, are due prior to ordering coating and surface preparation materials:

1. Coating manufacturer's color selection literature for coating materials and caulk.
2. Sample warranty document for products.
3. Provide certification from the manufacturer that all coatings will not contain more than 0.06 percent by weight of lead in the cured coating for each coat applied.
4. Coating manufacturer's Product Information and Safety Data Sheets (SDS) for each coating and caulk material. Product Information must include the following:
    a. The manufacturer's published instructions for use in specifying and applying all proposed coatings.
    b. Application instructions written and published by the coating manufacturer.
    c. All anticipated limitations, precautions and requirements that may adversely affect the coating, that may cause unsatisfactory results after the application or that may cause the coating not to serve the purpose for which it was intended, must be

clearly and completely stated in the instructions. Limitations and requirements must include, but are not necessarily limited to the following:

1). Surface preparation.

2). Method(s) of application.

3). Thickness of each coat (maximum and minimum DFT).

4). Drying and curing time of each coat.

5). Time (minimum and maximum) allowed between coats.

6). Thinner and use of thinner.

7). Proper mixing of coating before application.

8). Weather limitations during and after application (temperature and humidity, time weighted).

9). Physical properties of coating, including percent solids content by volume.

10). Equipment settings (air cap, fluid tip, equipment pressure settings, etc.).

11). Pot life at various temperature and humidity conditions.

12). Provide documentation that interior coating system is compatible with the cathodic protection system.

C. The following samples are required prior to ordering the materials:

1. Three samples of selected exterior finish colors for approval on 6-inch by 6-inch swatches. Label each swatch with the manufacturer's name, coating name/type, color name and number.

D. The following Product Data is required prior to coating work:

1. Coating Plan:

a. Anticipated coating process schedule by date, including dates when hold-point inspections are anticipated. Schedule must indicate detailed activities on a daily basis.

b. Detailed procedures and schedule for all pre-cleaning, surface preparation and application of coating, including touch-up and repair procedures for all coating systems.

c. Recoat schedule on the submitted coating materials.

d. Data sheets must include curing characteristics and recommendations regarding complete coating curing.

e. Provide a written plan documenting how spent cleaning debris and/or paint over spray or droplets will be contained/confined to the jobsite and tank site during the surface preparation and coating application operations. Reasonable care must be exercised by the Contractor to prevent damage, nuisance, or hazardous conditions to adjacent or nearby property Owners. Include all materials and method to be used for protection of exterior surfaces, and allow for recovery and disposal of paint scraps and blast media.

2. Provide documentation on proposed containment system methods for blasting and coating operations.

3. Contractor must submit evidence of notification of the appropriate office of the Texas Commission on Environmental Quality (TCEQ) prior to abrasive blasting as required. Submit copies of any obtained permits.

4. Coating Manifest - Within 48 hours of coating delivery to the jobsite, the Contractor must record the batch number stamped on each coating container and submit a typed list to the Owner's representative. Minimum information required is listed below.

   a. Date of delivery to jobsite.

   b. Name and signature of superintendent recording the data.

   c. List of batch number including corresponding coating identification, color, date of manufacture and volume of each container.

E. The following Certified Test Report(s) are required prior to coating work:

1. SDS sheets for all abrasive to be used on the Project.

2. Certification and laboratory test results indicating recycled metallic abrasive per SSPC-AB 2 or 4 and atomic absorption test results.

1.04 STANDARDS

A. The applicable provisions of the following standards apply as if written here in their entirety. Adhere to the latest standards and codes published by the following organizations.

B. In the event of a conflict between the published standards, codes, and this Section, the more stringent requirement govern as interpreted by the Engineer.

1.05 DELIVERY AND STORAGE

A. Deliver coating products to the Site in original unopened containers, with manufacturer's label and batch number attached. Do not apply products until the Owner's field representative has approved the product for use.

B. Use one location at each site for the storage of coating products. Protect the floor from spills and other damage. Protect the products from extreme heat or cold. Keep containers covered. Keep the storage rooms clean of trash and debris. Dispose of oily or used rags daily. Under no circumstances will they be allowed to accumulate. Take precautions to prevent fires. The storage of flammable liquids must comply with the City, State, or other fire codes.

C. Storage of coatings and other products must be in accordance with the manufacturer's requirements. Coatings that have been damage or not stored properly must not be applied and must be removed from the jobsite.

D. All products and coatings that are not approved for the Project must be removed from the jobsite and must not be stored at the jobsite.

E. All materials must be delivered to the jobsite in original sealed containers with the date of manufacture and batch number stamped thereon by the coating manufacturer. Materials are subject to random observations by the Owner's representative at the jobsite.

1.06 ENVIRONMENTAL CONDITIONS

A. Do not apply coatings under conditions that are unsuitable for the production of good results. Remove trash and debris from enclosed buildings and thoroughly clean prior to application of coatings. Do not begin application of coatings in areas where other trades are working, or where construction activities result in airborne dust or other debris. Do not apply coatings in conditions which do not conform to the recommendations of the coatings manufacturer.

B. Coatings must only be applied when conditions fall within the parameters listed in the manufacturer's printed data.

C. Contractor must provide dehumidification equipment sized to maintain dew point temperature 5 deg. F or more above surface temperature of metal surfaces to be prepared and coated.

D. Do not apply any coatings when weather conditions are unfavorable. In the event that climatic conditions are not conducive for best results, postpone application of coatings until conditions conform to the manufacturer's recommendations and the provisions of this Section.

E. Do not apply coatings to a wet or damp surface in wet or damp weather conditions, or when there is dust in the air. Surfaces exposed to direct sunlight must be shaded by awnings or other protective devices while coatings are being applied, if recommended by coating manufacturer. When necessary, provide temporary heating devices of a type that produces no fumes or water vapor which will discolor the paint system.

F. Heating and Dehumidification:

1. Dehumidification equipment must be used to control the environment during surface preparation, rehabilitation, coating application and coating curing at no additional cost to the Owner, if acceptable environmental conditions cannot be met.

   If the Contractor cannot meet the required environmental conditions to apply the interior coating system per this Section and the coating manufacturer's written recommendations, Contractor will cease operations until approved dehumidification equipment has been provided and acceptable environmental conditions are achieved.

   If coating system is applied without dehumidification or in conditions not acceptable by this Section and by the coating manufacturer's written requirements, Contractor must fully remove coating system applied and replace per the Engineer's direction.

2. Contractor must furnish all labor, materials, equipment, fabrication and quality control inspections, and all other incidentals required to control and maintain the environment of the reservoir within the parameters stated in this Section and must incorporate these and any other expenses into its bid.

3. The Owner reserves the rights, in the event the dehumidification equipment is not performing to the minimum requirements stated in this Section, to require the Contractor to modify and or add additional equipment to satisfy the conditions of this Section, at the sole cost to the Contractor.

4. It is the Contractor's responsibility to provide adequate dehumidification equipment to meet this specification and the coating manufacturer's requirements of this Section and

coating manufacturer's requirements. The coating manufacturer's limits of surface temperature, tank inside air temperature and relative humidity requirements will govern, if more stringent than the requirements stated within this Section.

G. Forced Ventilation:

1. Provide continuous forced fresh air ventilation when working inside of containment systems or enclosed areas that are not openly vented from the beginning of surface preparation through final coating operations and coating curing.
2. Forced ventilation must be supplied per the recoat time required by the coating manufacturer and at least 48 hours after the final coat has been applied.
3. From the beginning of interior coating applications to until the coating system is cured, the Contractor must monitor the air for the lower explosion limit (LEL) as published in the coating manufacturer's product SDS.
4. Contractor is responsible for supplying, installing and maintaining the forced ventilation system.

H. Containment System:

1. Contractor must provide containment methods, either full or partial, which allows for the containment of the environmentally sensitive waste, dust and paint over spray that will be generated during the abrasive blasting and painting operation.
2. Minimum Containment for Field Surface Preparation:
    a. Provide a minimum SSPC Guide 6 (CON) Class 3A.D1.E3 containment system when dry abrasive blasting.
    b. Provide a minimum SSPC Guide 6 (CON) Class 2W containment system when wet abrasive blasting. All water must be contained and properly disposed of.
    c. Provide a minimum SSPC Guide 6 (CON) Class 2P.E3 containment system when power tool cleaning.
3. The ground surrounding the project area must be protected from all debris, emissions, dust, and other materials generated in the cleaning operations with a minimum of two layers of polyethylene covered with plywood or the same material used for the perimeter containment system.
4. Containment is not required when blasting on the interior of a completely enclosed area (i.e. roof is in place) as long as no visible emissions are created.
5. The Contractor must ensure that no spent cleaning/blasting debris, dust, overspray, coating droplets, or emissions of any kind, escape to the atmosphere, or to adjacent buildings, private property, work sites, parking lots, etc.
6. The Owner reserves the right to stop work or require containment, additional containment or different containment methods if the Contractor's operations create a nuisance beyond the tank site property line in the sole opinion of the Owner, the Engineer, the Owner's representative, any regulatory agency, or neighbor. All costs of providing an adequate containment system must be included by the Contractor in the Base Bid.

7. Contractor will be responsible for all materials that are used and for any apparatus used to contain dust emissions, debris, overspray, and coating droplets. The containment system attachments to existing or proposed structures must be designed by a professional engineer, licensed in the state where the Project is located, not to impose excessive loading on the structure. Contractor must submit the designed and sealed details of the containment system on the tank.

8. Any damage to the structure(s) as a direct or indirect result of the containment system must be repaired or sections replaced by the Contractor at no additional cost to the Owner. Neither the Owner, nor the Owner's Engineer, assumes any responsibility for the structural ability of the structure to support the containment system.

9. If tarps are used as part of the containment system, the tarps must be an impervious, solid, flame-resistant material, reinforced with a fiber mesh and must allow as much light as possible to pass through the material.

I. Visible Emissions:

1. Contractor must control visible emissions and releases while dust producing activities are underway.

2. Visible emissions more than SSPC Guide 6, Level 1 (1 percent of the workday or 5 minutes in an 8-hour shift) are unacceptable. Sustained emissions of more than 1 minute, regardless of the total time of emissions for the day is unacceptable. If unacceptable emissions are observed, Contractor must shut down immediately and correct the situation and clean up any debris generated from the release to the satisfaction of the Engineer before continuing work.

1.07 WORKING CONDITIONS

A. Provide adequate lighting at any location that coatings are being applied or testing is performed. Illumination must be of sufficient intensity to achieve good results. Provide explosion-proof lighting when required.

B. Temporary ladders and scaffolds must conform to applicable safety requirements. Erect temporary scaffolds where needed to cover large areas. Provide ladders or scaffolding during testing procedures.

1.08 WARRANTY/GUARANTEE

A. Protective coating must be guaranteed for a period of 2 years from the date of the Owner's acceptance of the Project.

B. A warranty inspection must be conducted prior to the end of the warranty period. Any Defective Work discovered at this date must be corrected by the Contractor in accordance with the Contract Documents at no additional cost to the Owner.

2.00 PRODUCTS

2.01 GENERAL COATING REQUIREMENTS

A. All coatings must be free of heavy metals such as arsenic, barium, chromium, selenium, silver, lead, mercury and cadmium.

B. All coatings in contact with potable water must be certified as per NSF Standard 61.

C. All coatings submitted or used on this Project must comply with the EPA's Clean Air Act for maximum VOC (volatile organic compound) limits.

D. Finish coatings must be from the same batch.

2.02 MATERIALS

A. Coating products are to be as follows:

Type A - Alkyd-Phenolic Universal Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 37H Chem-Prime H.S.
Sherwin-Williams	Kem Kromik Universal
Akzo Nobel / International Paint, LLC	Interlac 573
Devoe Coatings	Devprime 1403
Carboline	Carbocoat 150UP
PPG	Multiprime 4360

Type B - Epoxy-Polyamide Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Copoxy Primer
Akzo Nobel / International Paint, LLC	Intergard 251; Intergard 269 for valves and gates, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Devran 201V Series
Carboline	890
PPG	Amercoat 385

Type C - Penetrating Epoxy Pre-Primer	
Manufacturer	**Approved Coating**
Tnemec	Approved Equal
Sherwin-Williams	Macropoxy 920 Pre-Prime
Akzo Nobel / International Paint, LLC	Interbond 600
Devoe Coatings	Approved Equal
Carboline	Rustbond Penetrating Sealer
PPG	Amerlock Sealer

Type D - Inorganic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-98 Tneme-Zinc
Carboline	Carbozinc 12 VOC
Sherwin-Williams	Zinc Clad II Plus
PPG	Dimetcote 9 VOC
Approved Manufacturer	Approved Equal

Type E - Organic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-97 or 90G-1K97 Tneme-Zinc
Carboline	Carbozinc 859
Sherwin-Williams	Corothane I Galvapac
PPG	Amercoat 68HS
Akzo Nobel / International Paint, LLC	Interzinc 52
Approved Manufacturer	Approved Equal

Type F - Alkyd Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 2H Hi-Build Tneme-Gloss
Sherwin-Williams	DTM Alkyd Enamel
Akzo Nobel / International Paint, LLC	Interlac 665
Devoe Coatings	Devlac 1431
Carboline	Carbocoat 8225
PPG	Fast Dry 35

Type G - Epoxy-Polyamide Coatings	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Macropoxy 646 Epoxy
Akzo Nobel / International Paint, LLC	Intergurd 475HS; Interseal 670HS for valves and gates, PVC pipe and conduit, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Bar-Rust 235
Carboline	Carboguard 60

Type G - Epoxy-Polyamide Coatings	
Manufacturer	**Approved Coating**
PPG	Amerlock 385

Type H - Epoxy-Polyamide Coatings for Potable Water (NSF 61 Certified)	
Manufacturer	**Approved Coating**
Tnemec	Series 20 Pota-Pox or N140 Pota-Pox Plus
Sherwin-Williams	Tank Clad Epoxy
Akzo Nobel / International Paint, LLC	Interline 850 or Interseal 670HS (NSF colors)
Devoe Coatings	Bar-Rust 233H Series
Carboline	Carboguard 61
PPG	Amerlock 2/400

Type I - Aliphatic Polyurethane Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 1074 Endura-Shield II
Sherwin-Williams	Hi-Solids Polyurethane
Akzo Nobel / International Paint, LLC	Interthane 990 Series
Devoe Coatings	Devthane 379 Series
Carboline	Carbothane 133HB (Satin) or Carbothane 134HG (High Gloss)
PPG	Pitthane Ultra Series

Type J - Silicone Aluminum Coatings For High Temperature	
Manufacturer	**Approved Coating**
Tnemec	Series 39 Silicone Aluminum
Sherwin-Williams	Silver Brite Aluminum B59S8
Akzo Nobel / International Paint, LLC	Intertherm 50 Series
Devoe Coatings	Intertherm 50 Series
PPG	Hi-Temp 500
Carboline	Carbozinc 11; Finish: Thermaline 4700 Series (up to 1000 deg. F); Thermaline 4900 (up to 450 deg. F)

Type K- Epoxy Concrete Coating	
Manufacturer	**Approved Coating**
Tnemec	Series 46H-413 Hi-Build Tneme-Tar

Type K- Epoxy Concrete Coating	
Manufacturer	**Approved Coating**
Sherwin-Williams	Tar Guard Epoxy
Akzo Nobel / International Paint, LLC	Interzone 954
Devoe Coatings	Devtar 5A Series
PPG	Amercoat 78HB Coal Tar Epoxy
Carboline	Bitumastic 300M

Type L - Novolac Vinyl Ester/Novolac Epoxy Concrete Coating - High Friction Surface (HFS)	
Manufacturer	**Approved Coating**
Tnemec	Series G436 Perma-Shield / Chembloc Series 252SC
Sherwin Williams	Dura-Plate 8200
Akzo Nobel / International Paint, LLC	Ceilcote 380 / 242GF Flakeline System
PPG	SFT 675 / FlakeRez 8303
Carboline	Carboguard 510 Series / Plasite 4500 Series

Type M - High Solids Epoxy Siloxane	
Manufacturer	**Approved Coating**
Carboline	Carboxane 2000
Sherwin-Williams	Sher-Loxane 800
PPG	PSX 700 Polysiloxane
Approved Manufacturer	Approved Equal

Type N - Epoxy Mastic	
Manufacturer	**Approved Coating**
Carboline	Carbomastic 15
Sherwin-Williams	Epoxy Mastic II
PPG	Amerlock 2/400 AL
Tnemec	Chembuild Series 135
AkzoNobel/International Paint, LLC	Interseal 670HS

Type O - Elastomeric Polyurethane Hybrid	
Manufacturer	**Approved Coating**
Carboline	Reactamine 760 Series
Sherwin-Williams	Sherflex S
PPG	Amerthane 490
Tnemec	Elasto-Shield Series 406
AkzoNobel/International Paint, LLC	Polibrid 705E Elastomeric

Type P - Glass Flake Reinforced Epoxy	
Manufacturer	**Approved Coating**
Carboline	Approved Equal
Sherwin-Williams	Sher-Glass FF
PPG	Amerlock 2/400 GF
Tnemec	Tnemec Series G435
AkzoNobel/International Paint, LLC	Approved Equal

Type Q - 100 Percent Solids Epoxy for Wastewater	
Manufacturer	**Approved Coating**
Carboline	Plasite 4550-S Novolac Epoxy
Sherwin-Williams	Dura-Plate 6000 Amine Epoxy
PPG	Novaguard 890 or Novaguard 810 Novolac Epoxy
Tnemec	Perma-Glaze Series G435 or Series G436 Modified Polyamine Epoxy
AkzoNobel/International Paint, LLC	Approved Equal

B. Petrolatum (Wax) Tape:

1. Petrolatum (wax) tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.
2. Approved Manufacturers:
    a. Trenton Corp. - Trenton Primer and #1 Wax-tape
    b. Denso North America, Inc. - Denso Paste and Densyl Tape
    c. Approved equal.

C. Pipe Wrap Tape System:

1. System must be designed to mechanically protect coated piping from corrosion and abrasion in above ground, below ground and submerged conditions and be compatible with specified pipe coating system(s).
2. System must be UV resistant and may be constructed of HDPE, PVC, or fiberglass with an adhesive backing on one side for application to coated piping.
3. System must include a fiberglass reinforced outer shield for abrasion resistance and be able to be top coated for aesthetics.
4. Approved Manufacturers:
    a. SealForLife.
    b. Denso North America, Inc.
    c. Approved equal.

2.03 COLOR SELECTION

A. The color chart must include the complete available range of colors, including tints and shades. Owner will select the colors during construction.

B. Use a multi-color system coating for any surface receiving more than one coat. Each coat must be tinted differently from the preceding coat in a manner that will allow the various coats to be easily distinguished. Colors must generally be from light to dark shades, but the Contractor may have the option to select tint shades to insure coats will receive adequate coverage without bleeding or otherwise showing through the preceding coat.

C. Piping and equipment must be color coded in accordance with the requirements of the TCEQ.

3.00 EXECUTION

3.01 GENERAL

A. All coatings must be applied in strict conformance with the coating manufacturer's published specifications, this Section, or as approved by the Engineer.

B. Surfaces which will be inaccessible after installation must be coated prior to installation, or must be coated and approved in stages as the work is installed.

C. The Engineer will approve surfaces for application of coatings at each stage. Any material that is coated prior to the Engineer's approval will be stripped back to bare metal and repainted.

D. At least 7 days or as required by the coating manufacturer, must be allowed for drying of finished surfaces before any machinery can be placed into service.

E. The number of coats called for in this Section are considered the minimum required. If more coats are required to provide the specified dry film thickness or for complete coverage and uniform appearance, they must be provided at no additional cost to the Owner.

3.02 STEEL SURFACE PREPARATION

A. The adequacy of the preparation of steel surfaces will be determined by comparing the surface with SSPC VIS 1 “Pictorial Surface Preparation Standards for Painting Steel Surfaces” and SSPC VIS 3 “Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning.” Prepare surfaces in accordance with the following requirements:

1. SSPC-SP 1 — Solvent Cleaning.
2. SSPC-SP 2 — Hand Tool Cleaning.
3. SSPC-SP 3 — Power Tool Cleaning.
4. SSPC-SP 5 / NACE 1 — White Metal Blast Cleaning.
5. SSPC-SP 6 / NACE 3 — Commercial Blast Cleaning.
6. SSPC-SP 7 / NACE 4 — Brush-Off Blast Cleaning.
7. SSPC-SP 10 / NACE 2 — Near-White Blast Cleaning.
8. SSPC-SP 11 — Power Tool Cleaning to Bare Metal.

B. The resulting surface profile must be in accordance with the coating manufacturer’s recommendations.

C. “Solvent Cleaning” must be performed prior to subsequent surface preparation, including abrasive blast cleaning.

D. All sharp edges and welds must be ground smooth to a rounded contour and all weld splatter must be removed prior to abrasive blasting. Edges of metal to be coated must be rounded to a minimum of 1/16-inch radius of chamfered a minimum of 1/16 inch at an angle of 45 degrees.

E. Welds and adjacent areas:

1. Prepared such that there is:
    a. No undercutting or reverse ridges on the weld bead.
    b. No weld spatter on or adjacent to the weld or any other area to be painted.
    c. No sharp peaks or ridges along the weld bead.
    d. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
2. Weld profiles must conform to NACE RP0178, Profile ‘D’.

3.03 DUCTILE IRON PIPE AND FITTINGS SURFACE PREPARATION

A. Prepare surfaces in accordance with the following requirements:

1. NAPF 500-03-01 — Solvent Cleaning.
2. NAPF 500-03-02 — Hand Tool Cleaning.
3. NAPF 500-03-03 — Power Tool Cleaning.
4. NAPF 500-03-04 — Abrasive Blast Cleaning for Ductile Iron Pipe.

5. NAPF 500-03-05 — Abrasive Blast Cleaning for Cast Ductile Iron Fittings.

B. "Solvent Cleaning" must be performed prior to subsequent surface preparation as specified in NAPF 500-03.

3.04 PETROLATUM (WAX) TAPE

A. Petrolatum (wax) tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.

B. Tape must be installed on all buried flexible couplings and at locations indicated on the Drawings and as specified.

3.05 PIPE WRAP TAPE SYSTEM

A. Tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.

B. Tape must be installed on all piping at the transition between above grade and below grade. Coat piping a minimum of 2 feet vertically above and below the ground surface.

C. Paint wrap to match adjacent piping.

3.06 CONCRETE SURFACE PREPARATION

A. The adequacy of the preparation of concrete surfaces will be determined by comparing the surface with ICRI Surface Finish Comparators. Prepare surfaces in accordance with the following requirements and the coating manufacturer's recommendations:

1. SSPC-SP 13 / NACE 6 — Surface Preparation of Concrete.

2. ICRI CSP 3 – 5, or as required by the coating manufacturer.

B. Allow a minimum of 28 days curing time to elapse before coatings are applied. Concrete surfaces which are scheduled to receive coatings must be in accordance with the coating manufacturer's moisture requirements. Contractor must provide any primers required by the coating manufacturer to address outgassing, as needed.

C. Contractor must field verify that the pH of the concrete is suitable for application per the coating manufacturer's product requirements.

D. Bug holes, air pockets, voids or imperfections in the concrete surface must be filled or patched with a cementitious resurfacing material approved by the coating manufacturer.

E. All coating terminations points, including from concrete to metal are to include a 1/4-inch key cut.

F. Concrete Surface Preparation Inspection:

1. Adhesion Testing:

a. Tensile testing of the surface preparation must be performed by the Contractor using a Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D7234 using 2-inch diameter dollies for concrete surface adhesion testing.

Provide a minimum of three tests (dollies) per area and coating system. Engineer will select location of test dollies.

b. Concrete surface or applied coating must be scored for concrete adhesion testing.

c. Adhesive failure greater than 50 percent of the dolly surface area indicate inadequate surface preparation.

d. Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.

e. Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.

2. Concrete Soundness: Concrete soundness will be determined using the scratching or hammer impact methods as defined in SSPC-SP 13.

3. Moisture Content: Moisture must be tested as specified in SSPC-SP 13 and in accordance with ASTM D4263 and ASTM F1869 (for conditioned spaces). Moisture content cannot exceed the moisture content recommended by the coating manufacturer.

3.07 SURFACE PREPARATION

A. Clean and degrease surfaces prior to abrasive blasting by solvent cleaning as specified using solvents, detergent/water, emulsions, and steam. Proposed method must be documented in the coating plan. Contractor must contain and properly dispose of all runoff and debris from cleaning.

B. If the following conditions exist or are prevalent, surface preparation and coating must be delayed or postponed until conditions are favorable. Each day's coating must be completed in time to permit the film sufficient drying time prior to damage by atmospheric conditions or changes. No surface preparation can begin or coating applied:

1. When the surface, air or material is below or above the manufacturer's printed instructions.

2. When surfaces are wet or damp.

3. During weather conditions of rain, snow, fog or mist.

4. When the air and steel temperature is less than 5 deg. F above the dew point temperature.

5. If the relative humidity is above 85 percent.

6. When it is expected that the dew point, air and/or surface temperature will be below or above the coating manufacturer's recommended temperatures within 4 hours after applications of coating, minimum. Coating manufacturer may require additional time between application and temperature and weather changes.

C. Shop Surface Preparation:

1. Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints. Work is subject to the Engineer's approval before shipment to the jobsite.

2. Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed and approved by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with the Specifications.

3. Prepare surfaces by abrasive blasting as specified and apply shop prime coat. Shop primed steel plates must not have primer extended within 4 inches along all edges to be welded. All primer within 4 inches of an area to be welded must be removed prior to welding. Welding of painted surfaces will not be allowed.

D. All pre-assembled shop primed items must be prepared in accordance with these specifications and inspected by the Owner's representative before and after priming.

E. Abrasive Blasting:

1. Prior to commencing abrasive blasting operations, the Contractor must perform a test blast to verify that the surface cleanliness and profile meet the requirements of this Section and meet the coating manufacturer's requirements for the coating to be applied. If the test section does not meet the requirements, the Contract must make changes to the abrasive materials and/or methods to provide suitable blast.

2. Abrasive blast only the amount of surface area which can be primed the same day or before any rust starts to form, whichever occurs first. Areas which are not painted the same day must be re-blasted on the day the prime coat is applied.

3. Shrouding or recovery of all blast material will be mandatory during all exterior blasting.

4. Contractor must contain all waste and process discharge in accordance with the accepted methods for the process and materials that are in abatement.

5. Where abrasive blast cleaning will not remove or properly prepare metal surfaces, hand and/or power tool cleaning must be used to remove such conditions as weld splatter, laminations and radius-sharp edges. Hand tool or power tool must be used on areas less than 2 feet in diameter or smaller or on corners and edges.

6. All abrasive blast equipment must be equipped with, including but not limited to the following:

a. Noise reducing devices.

b. Hose coupling safety devices.

c. Electrical grounding devices.

d. Moisture traps and filters.

e. Fresh air hoods for all blasters.

f. "Dead Man" switches on all blast hoses.

g. Air dryers.

F. Surface profile must be in accordance with manufacturer's printed requirements.

G. The adequacy of the preparation of surfaces must be determined by comparing the surface with SSPC-VIS 1, SSPC-VIS 3, NACE RP0178 and ICRI Surface Finish Comparators.

H. Adequate surface preparation must be verified throughout surface preparation per SSPC-PA 17. Minimum testing requirements:

1. Test the surface profile within the first 15 minutes and one additional time during each work shift or 12-hour period, whichever is shorter for each gun or blasting apparatus used or at any time the process producing the acceptable profile indicated above is changed, as interpreted by the Engineer.

2. Select a minimum of three 6-inch square locations and take two readings. The average to the two readings is a "profile measurement." The group of three locations is the "location average." The location average must be within the specified profile range.

3. Contractor must report the location averages (lowest location average and highest location average, and the profile measurement for each surface preparation apparatus.

4. If the substrate has been previously coated, an existing profile may exist. Contactor must adjust blast media size to ensure that the resulting surface profile meets the profile required.

I. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in the specifications or in paint manufacturer's specifications, they are understood to refer to the applicable specifications indicated.

J. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacuum-blasting methods may be required. Coating manufacturer's recommendations for wet blast additives and first coat application will apply.

K. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.

3.08 PREPARATION OF HOT-DIP GALVANIZED COATED STEEL, STAINLESS STEEL AND NON-FERROUS METALS

A. For galvanized coated steel, remove all soluble and insoluble contaminants. Prepare hot-dipped galvanized coated iron and steel products in accordance with ASTM D6386.

B. Abrasive blast per SSPC-SP I6 to achieve an angular anchor profile as required by the coating manufacturer.

C. Contractor is responsible for coordinating with the coating manufacturer to verify compatibility of the specified coating system with the provided surface preparation.

3.09 PREPARATION OF EXISTING COATED OR SHOP PRIMED SURFACES

A. General:

1. Factory-applied primers to equipment must be those specified or verified by the Contractor to be compatible with the specified coating systems. Where possible, notify manufacturers which shop prime coats will be required in order to be compatible with field-applied finish coats.

   Where equipment is purchased which has the manufacturer's standard primer or a factory finish which is other than as specified in this Section, remove the factory-applied

paint system or apply passivators or other special coatings as required to make the surface compatible with the finish coat specified.

2. Do not apply any coating to machinery, piping, or other surfaces before testing has been completed and systems approved. Any damage to coatings resulting from subsequent corrective procedures must be stripped back to bare metal and repainted with the appropriate paint system as directed by the Engineer.

3. Check for compatibility when applying coatings over existing coatings. Apply a test patch of the recommended coating system, covering at least 2 to 3 square feet or as directed by the Engineer. Allow to cure 1 week before testing adhesion per ASTM D3359 in the presence of the Engineer. If adhesion does not meet the manufacturer's published data, consult with the Engineer.

4. Shop primed or coated surfaces must be reviewed with the Engineer to determine if the extent of damage to the coating and suitability of finish coats to adhere to shop applied coats.

5. If a cured epoxy, polyurethane, or plural-component material is to be top coated provide brush-off blast as specified herein or as recommended by the coating manufacturer.

6. Surface preparation recommendations of coating manufacturer are subject to approval of the Engineer.

B. To Be Recoated or Final Coated:

1. Solvent clean.

2. Perform touch-up repairs of existing coating.

3. Asphaltic coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.

C. Touch-Up Repairs:

1. Clean loose, abraded, or damaged coatings to substrate by power tool to bare metal per SSPC-SP 11 and/or NAPF 500-03-03 "Power Tool Cleaning."

2. Feather surrounding intact coating.

3. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.

4. Apply one full finish coat of the specified primer or finish coat(s) overall.

D. Application of a Cosmetic Coat:

1. The exact nature of shop-applied coatings is not known in all cases.

2. Check compatibility by application to a small area prior to starting the coating.

3. If lifting or other problems occur, request disposition from the Engineer.

3.10 APPLICATION

A. Contractor and painting technicians are responsible for the application of the coating system and must have current applicator approvals from the coating manufacturer, as required.

B. After abrasive blast cleaning, dust and spent abrasive must be removed from the surfaces by vacuum process or with clean, dry, oil-free compressed air.

C. The prime coat must be applied as soon as possible after the blasting and surface cleaning is completed, inspected and approved by the Inspector. Blasted surfaces must be coated before rust forms on the surface. No prepared surface will be allowed to receive a coating if "rust bloom" or surface discoloration has occurred. All blasted surfaces must be coated to within 6 inches of the edge of a blasted area. No visible rust must be coated under any circumstances, including rust bloom or if discoloration has occurred, regardless of elapsed time between blasting and coating. Leave an uncoated strip of exposed metal to clearly identify where abrasive blasting was halted.

D. Provide mist coat if recommended by the coating manufacturer.

E. All weld seams, gaps, edges, bolts and difficult areas to coat must receive a stripe coat. Stripe coat must be a contrasting color. Stripe coat may be applied with intermediate or finish coating, but must be applied prior to the installation of the finish coat.

F. Contractor must apply each coat at the rate and in the manner specified by the coating manufacturer, except as may be modified herein. If material has thickened or must be diluted for application, coating must be built up to achieve the dry film thickness as specified for each coat of the complete system.

G. Maximum and minimum DFT must be per the supplied coating manufacturer's printed requirements and as required by this Section. DFT will be measured per SSPC-PA 2, Level 2 with an allowable measurement of spot DFT of:

   1. Minimum DFT, as specified.

   2. 120 percent of maximum DFT specified.

H. Contractor and painting technicians are responsible for the application of coating system and must have current applicator certifications from the coating manufacturer. Submit certifications with coating submittal.

I. Coatings which have an expired shelf or pot life may not be used and must be removed from the jobsite.

J. Coating must be applied by skilled workmen and must be brushed out or sprayed evenly, without runs, crazing, sags, or other blemishes.

K. Sand between coats to remove over spray and dry fall.

L. Apply the first coat to the surface, including cutting in around edges, before the second coat is applied. The second coat and any successive coats must not to be applied before notifying the Owner's field representative and obtaining approval. Each coat must be tested before the successive coat is applied.

M. The coating curing period must be adjusted to compensate for less than adequate weather conditions, as recommended by the coating manufacturer, for complete curing of the entire coating system. The full curing time recommended by the manufacturer must be provided.

N. Coating must be continuous and must be accomplished in an orderly manner to facilitate proper inspection control.

O. Where a roller or brush is used to apply the coating, additional coats may be necessary to achieve the recommended dry film thickness and/or to achieve total coverage of the underlying surface. Coated surfaces must be totally free of all roller nap, roller marks, brush bristles and brush marks.

P. When using conventional coating spray equipment for coating operations, effective oil and water separators combined with after coolers or deliquescent dryers must be used in compressed air lines to remove detrimental oil and moisture from the air. Separators must be placed as far as practical from the compressor. Compressors must be tested periodically by the Contractor for oil and water contamination of compressed air. Testing must follow ASTM D4285 "Standard Test Method of Indicating Oil and Water in Compressed Air." All compressor units found to produce unacceptable amounts of oil and or water, as determined by results of ASTM D4285 test data must be replaced with a compressor that is acceptable.

Q. For porous surfaces, such as concrete or masonry, a prime coat may be thinned to provide maximum penetration and adhesion. The type and amount of thinning must be determined by the coating manufacturer and is dependent on surface density and type of coating.

R. Concrete and Steel Floors and Walks, including Bulk Storage Areas:

1. Provide non-skid surface in walkway areas and on floors.

2. Contractor is to include non-skid additive such as aluminum oxide to coatings or may use 50 mesh dry wash silica sand broadcasted into the film and back rolled to encapsulate as recommended by the coating manufacturer.

3. Contractor is to provide a test area to confirm with Owner that the non-skid surface is adequate and consistent. Contractor must modify method or products used as required to provide an acceptable surface.

3.11 WATER AND WASTEWATER PIPE COLORS

A. General coating colors in accordance with the TCEQ are as follows for general selection of pipe coatings. Contractor must provide samples for Engineer's approval prior to ordering as specified.

Pipe/Pumps/Valves System Description	Color
Power Conduits	In compliance with the National Fire Protection Association 70 National Electrical Code
Raw Water	Tan

3.12 FIELD QUALITY CONTROL

A. Field Tests: Make wet film tests during painting operations to assure proper thicknesses of coating are being applied. After each coat has been applied, test the paint film thickness with a nondestructive, magnetic type thickness gauge. The total dry-film thickness for each coat must be per Paragraph 3.18. Apply additional coats until the specified thickness is reached or exceeded.

B. Holiday Testing

1. Holiday testing must be performed in accordance with NACE SP0188 or ASTM D5162 for steel substrates and ASTM D4787 for concrete substrates.

2. Test the entire surface of coated steel and piping in moderate or severe environments, as determined by the Engineer, with a holiday detector. For thickness between 10 and 20 mils (250 to 500 microns) a non-sudsing type wetting agent, as recommended by the holiday detector manufacturer, must be added to the water prior to wetting the detector sponge.

3. Holiday detect coatings in excess of 20 mils with high voltage holiday testers as recommended by the coating manufacturer.

4. Mark and repair failures in accordance with the manufacturer's printed instructions, then retest failure areas. No failures or other irregularities will be permitted in the final coats. Areas containing holidays must be repaired until tests indicate no holidays.

3.13 PROTECTION OF SURFACES NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.14 DAMAGED COATINGS, PINHOLES, AND HOLIDAYS

A. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.

B. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator must provide liquid repair kits for this purpose as recommended by the coating manufacturer.

C. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.15 UNSATISFACTORY APPLICATION

A. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.

B. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.

C. Evidence of runs, bridges, shiners, laps, or other imperfections are cause for rejection.

D. Repair defects in coating system per written recommendations of coating manufacturer.

E. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.16 COATING INSPECTION

A. General:

1. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.

2. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

3. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper millage in these areas.

B. Coating Thickness Testing:

1. Owner's representative may conduct coating thickness testing as necessary and without limitation.

2. Measure coating thickness specified in mils with an electronic type dry film thickness gauge.

3. Check each coat for the correct millage.

4. Tests for concrete coating thickness may be taken using a Tooke Gauge or gauge approved for testing coatings over concrete substrates. Contractor must repair coating after thickness testing, if required.

C. Coating Continuity (Holiday) Testing: Owner's representative will witness holiday testing performed by the Contractor.

3.17 CLEANING AND ADJUSTING

A. Promptly remove trash and debris resulting from painting operation from the Site. Remove drop cloths, masking tapes and other protective coverings. Remove paint spills, splatters, overlap of paint from adjacent material and other defects. Spot paint nicks and other defects.

B. Remove paint containers and waste products. Thoroughly clean paint storage rooms, removing spilled paint from walls and floors.

C. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.18 SCHEDULE

A. Protective coatings must be applied in accordance with the following paint schedule. If additional or alternate primers, etc. are recommended by the coating manufacturer for any of the coatings specified, they must be provided at no additional cost to the Owner to provide a complete and compatible coating system, as approved by the Engineer.

PROTECTIVE COATINGS PAINT SCHEDULE

System	Application Description	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
No. 1	**Submerged Metal - Potable Water** All metal surfaces new and existing below a plane 1 foot above the maximum liquid surface, metal surfaces above the maximum liquid surface which are a part of the immersed equipment, concrete embedded surfaces of metallic items under submerged or buried conditions, such as wall pipes, pipes, wall or floor sleeves, access manholes, gate guides and thimbles, and structural steel. Not to be used for potable water storage tanks. All coatings must be NSF 61 certified.	SSPC-SP 1 SSPC-SP 10 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05	TYPE H - Epoxy-Polyamide TYPE H - Stripe Coat TYPE H - Epoxy-Polyamide	1 2	4.0 4.0
				Total Minimum Dry Film Thickness	**12 mils**
No. 2	**Above-Grade Interior/Exterior Steel and D.I. Piping Non-Immersion/Non-Corrosive Environment** All metal surfaces new and existing, such as inside pump station buildings, exterior piping and valves, exterior structural steel, etc. **Application Notes:** 1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field. 2. Proposed Field Coated and Existing Previously Coated Piping and Valves - Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and top coat as indicated.	**For New Piping and Valves:** SSPC-SP 1 SSPC-SP 6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP 1 SSPC-SP 3 NAPF 500-03-01 NAPF 500-03-03	TYPE N - Epoxy Mastic TYPE C - Penetrating Epoxy Pre-Primer TYPE M - Stripe Coat Type M - HS Epoxy Siloxane	1 1 1	5.0 2.0 5.0 - 7.0
				Total Minimum Dry Film Thickness	**12 mils**
No. 3	**Concrete Floor Surfaces/Bulk Storage Areas of Chemical Storage Areas** All new and existing interior concrete floors, such as inside pump station buildings and chemical storage areas. All coatings must include skid-resistant additives.	SSPC-SP 13 ICRI CSP 3-5	Primer - As Needed TYPE L - Epoxy/Vinyl Ester	1	35 mils

System	Application Description	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
	Application Notes: Provide epoxy primer as required by coating manufacturer to address outgassing and resurfacing as required.				
				Total Minimum Dry Film Thickness	**35.0 mils**
No. 4	**Electrical Equipment - Exterior** All new and existing exterior electrical panels and equipment with factory coatings. Not for pumps and motors.	SSPC-SP 1 SSPC-SP 2	TYPE A - Alkyd-Phenolic Universal Primer TYPE F - Stripe Coat TYPE F - Alkyd Enamel	1 2	2.0 3.0
				Total Minimum Dry Film Thickness	**8.0 mils**
No. 5	**High-Temperature Surfaces** Interior and exterior surfaces of surfaces with temperatures from 200 to 400 deg. F.	SSPC-SP 1 SSPC-SP 10	TYPE J - Silicone Aluminum	2	1.0
				Total Minimum Dry Film Thickness	**2.0 mils**
No. 6	**Above-Grade Interior and Exterior PVC Pipe** Exterior surfaces PVC piping.	SSPC-SP 1 Light Sanding	TYPE B - Epoxy-Polyamide Primer TYPE I - Aliphatic Polyurethane Enamel	1 1	3.0 3.0
				Total Minimum Dry Film Thickness	**6.0 mils**
No. 7	**Metal Piping and Valves – Immersion in Wet Wells Moderate to Severe Environment (Non-Potable)** Exterior/interior surfaces of submersed valves & pumps, penstocks, piping, sewer interceptors, wastewater vessels, settling tanks and buried piping connecting to them for severe conditions with exposure to H2S gas, including wastewater digesters, etc. **Application Notes:** Coating may be applied in two coats, as recommended by the manufacturer.	SSPC-SP 1 SSPC-SP 6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05	Type Q - 100% Solids Epoxy for Wastewater	1 - 2	40.0
				Total Minimum Dry Film Thickness	**40 mils**

System	Application Description	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
No. 8	**New and Existing Metal Piping and Valves within Vaults and Under Insulation** **Moderate to Severe Environment** All metal surfaces new and existing that will be installed in areas where temporary submerged conditions can occur, such as within vaults and for piping and valves covered with insulation. **Application Notes:** 1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field. 2. Proposed Field Coated and Existing Previously Coated Piping and Valves - Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and top coat as indicated.	**For New Piping and Valves:** SSPC-SP1 SSPC-SP6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP1 SSPC-SP3 NAPF 500-03-01 NAPF 500-03-03	TYPE N – Epoxy Mastic TYPE C – Penetrating Epoxy Pre-Primer TYPE G - Stripe Coat TYPE G – Epoxy-Polyamide	1 1 2	4.0 2.0 4.0
			Total Minimum Dry Film Thickness		**12 mils**

END OF SECTION

09 97 16 PIPELINE COATINGS AND LININGS

1.00 GENERAL

1.01 WORK RESULTS

A. This Section covers the Work necessary to apply external polyurethane coating on steel pipe, field coating of joints, and field repair of coating damage, complete.

B. Concrete cylinder pipe shall be externally overcoated with polyurethane coating system where specifically indicated on the Drawings.

C. Exposed steel pipe will be coated as specified in Section 09 96 00.01 “High-Performance Coatings” unless specifically specified otherwise.

1.02 SUBMITTAL REQUIREMENTS

A. Contractor submittals shall be made in accordance with Section 01 33 00 “Document Management.”

B. Shop Drawings: Catalog cuts; material safety data sheets; manufacturer’s recommendations and instructions on surface preparation, application and curing; product performance reports; and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Coatings Inspector: Submit certification from NACE Certified Coatings Inspector Level III indicating the pipeline was properly inspected and defective coatings detected were properly repaired.

D. Quality Control Submittals: Furnish the following:

1. Applicator's Experience with list of references substantiating compliance.

2. Coating manufacturer's certification stating the applicator meets or exceeds their coating application requirements and recommendations.

3. Coating manufacturer shall provide a copy of the manufacturer’s coating application quality assurance manual.

4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers’ that the two coating materials are compatible.

5. Certified Test Reports for all coating and lining.

6. At the start of coating and/or lining operations, the manufacturer shall certify that the coatings are being applied in accordance with the Specifications.

7. Submit reports from monthly follow-up site visits from manufacturer stating that the shop-applied coatings are being applied in accordance with the Specifications based upon monthly visits.

1.03 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:

1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years' practical experience in application of the indicated coating system.

2. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. Coating and/or lining manufacturer technical representative shall be present for a minimum of 2 weeks for technical assistance and instruction at the start of coating and/or lining operations within the shop. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to ensure conformance with application instructions, recommended methods, and conditions.

C. Prior to shipping, each finished pipe, fitting shall be inspected for markings, metal thickness, coating thickness, lining thickness (if shop applied), joint dimensions and roundness. The final inspection will also include testing for exterior coating holidays, adhesion, pitting scaring and any visible defects.

D. Coating and/or lining manufacturer technical representative shall be on-site for 2 weeks, minimum, at the start of each construction season to inspect coating application and procedures in the field. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

E. Coating and/or lining manufacturer shall include 8 hours per month of field or shop coating technical support when requested by the Engineer.

F. Coating and/or lining manufacturer technical representative shall provide a written report to the Engineer for each visit. Report shall include copies of test data collected, description of observations, and all recommended corrective actions. Report shall be submitted within 5 working days after the visit. When deemed necessary by the Engineer, Work will not be permitted to proceed until the recommended corrective actions have been implemented. After all corrective recommendations have been completed; the manufacturer representative shall return and certify that the application complies with the manufacturer's coating application recommendations.

G. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this Project.

1.04 ABBREVIATIONS

A. The following abbreviations are used in this Section:

Abbreviations	
ANSI	American National Standards Institute
ASTM	ASTM International
AWS	American Welding Society
AWWA	American Water Works Association
ISO	International Organization of Standards
MDFT	Minimum Dry Film Thickness
Mils	Thousandths of an Inch
NACE	NACE International
NSF	NSF International
OSHA	Occupational Safety and Health Act
SSPC	Society for Protective Coatings

1.05 DEFINITIONS

A. Manufacturer's Representative: Employee of coating manufacturer who is factory trained and knowledgeable in all technical aspects of their products and systems. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

B. Owner Technical Representative: A third party coatings and linings inspector with NACE training and acting under the supervision of a NACE Level III Coatings Inspector.

1.06 REFERENCE STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) / NSF International (NSF) Standards:

ANSI/NSF 60	Drinking Water Treatment Chemicals – Health Effects
ANSI/NSF 61	Drinking Water System Components – Health Effects

2. ASTM International (ASTM) Standards:

ASTM C33/C33M	Standard Specification for Concrete Aggregates
ASTM C150/C150M	Standard Specification for Portland Cement
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension

ASTM D522/D522M	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D2240	Standard Test Method for Rubber Property – Durometer Hardness
ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E96/E96M	Standard Test Methods for Water Vapor Transmission of Materials
ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM G95	Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

3. American Water Works Association (AWWA) Standards:

AWWA C205-80	Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied
AWWA C209	Cold Applied Tape Coatings for the Exterior for Steel Water Pipe, Special Sections, Connections, and Fittings
AWWA C210	Liquid-Epoxy Coatings and Linings for Steel Water Pipeline and Fittings
AWWA C216	Heat-Shrinkable Cross-linked Polyolefin Coatings for Steel Water Pipe and Fittings
AWWA C217	Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings
AWWA C222	Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipelines in Place – 4-inch and Larger

4. International Organization for Standardization (ISO) Standards:

ISO 8502-3	Preparation of Steel Substrates before Application of Paints and Related Products – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)

5. National Association of Corrosion Engineers (NACE) Standards:

NACE SP 0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP 0274	High Voltage Electrical Inspection of Pipeline Coatings
NACE RP 0287	Field Measurement of Surface Profile of Abrasive Blast-Cleaning Steel Surfaces Using Replica Tape

6. Steel Structures Painting Council (SSPC) Standards:

SSPC-SP-1	Solvent Cleaning
SSPC-SP-2	Hand Tool Cleaning

SSPC-SP-3	Power Tool Cleaning
SSPC-SP-5	White Metal Blast Cleaning
SSPC-SP-6	Commercial Blast Cleaning
SSPC-SP-10	Near-White Blast Cleaning
SSPC-SP-11	Bare Metal Power Tool Cleaning

1.07 SPECIAL WARRANTY REQUIREMENTS

A. The Contractor and coating applicator shall warrant to the Owner and guarantee the Work under this Section against defective workmanship and materials for a period of 2 years commencing on the date of final acceptance of the Work.

1.08 OBSERVATION OF WORK

A. The Contractor shall give the Owner Technical Representative a minimum of 14 days advance notice of the start of any Work to allow scheduling for shop or field observation. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application Work.

B. Provisions shall be made to allow Owner Technical Representative full access to facilities and appropriate documentation regarding coating application.

C. Observation by the Owner Technical Representative or the waiver of observation of any portion of the Work shall not be construed to relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

D. Materials shall be subject to testing for conformance with the Contract Documents as the Owner Technical Representative may determine, prior to or during incorporation into the Work.

2.00 MATERIALS

2.01 GENERAL

A. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written directions of the coating or lining manufacturer's, and this Section, whichever is more stringent.

B. Coatings and linings will be stored, handled, and applied per manufacturer's written directions.

C. Pipeline coating or lining shall be the product of a single manufacturer. Product substitutions during the Project will not be permitted.

2.02 CONTRACTOR FURNISHED TEST EQUIPMENT

A. Contractor shall provide the following coating test equipment for field testing of pipe for holidays:

1. Holiday Test Equipment:

a. Elcometer Model D236, 0 to 30 kV high voltage tester.

b. External pipe rolling spring probe, sized for the Project pipe diameter.

c. Right-angle wire brush probe, 20-inches or larger.

d. Telescopic probed extension handle, 2 to 4-foot length range.

2.03 EXTERIOR SHOP-APPLIED COATINGS

A. General:

1. Steel pipe shall be coated in accordance with AWWA C222, except as modified herein.

2. Concrete cylinder pipe shall be externally overcoated with polyurethane coating as specified herein and in accordance with the coating manufacturer's recommendations for concrete substrates.

3. Overcoating of concrete cylinder pipe with polyurethane shall be performed from joint to joint and shall include the minimum length as shown on the Drawings.

4. Pipe that is atmospherically exposed shall be shop primed as specified herein and in Section 09 96 00.01 "High-Performance Coatings."

5. Buried dielectrically coated pipe and fittings passing through a structure wall or floor shall be coated for a minimum of 2 inches beyond the interior wall or floor surface.

B. Plural Component Polyurethane:

1. General: Plural component, polyurethane coating system (referred to as a polyurethane system) shall be applied in accordance with AWWA C222, and as modified herein.

2. Shop Surface Preparation:

a. Steel pipe: SSPC-SP5, White Metal blast, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater using standardized testing procedures.

b. Concrete Pipe:

1). Abrasive blast to remove all laitance and loose material and create a suitable anchor profile.

2). Cement mortar coating shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement, whichever is greater.

3). Mortar coating shall be dry during coating application.

3. Shop Applied Coating Requirements:

a. Self-priming, plural component, 100 percent solids, non-extended polyurethane, suitable for burial or immersion.

b. One coat, 35 mils total dry film thickness, minimum, or as required to meet the holiday and coating defects limits specified in this Section.

c. Shall be one of the following products, subject to review and acceptance of submitted product performance reports:

1). Protec II, Futura Coatings, Montgomeryville, PA.

2). Chemthane 2265, Chemline, Inc, St. Louis, MO.

3). Polyclad 777, Carboline Global, St. Louis, MO.

4). Durashield 110 or Durashield 210, LifeLast, Pflugerville, TX.

5). No approved equal.

d. Acceptance of submitted product is contingent upon:

1). Submission of an independent testing report conducted within 3 years prior to bid opening documenting conformance to the coating performance criteria specified herein.

2). Verification that no significant change in product formulation has occurred through comparison of current product Part A and B formulation with infrared spectrometry analysis of test product for the laboratory test report.

4. Laboratory Coating Testing and Report:

a. General: Coating manufacturer shall submit to the Engineer for approval, test reports indicating conformance to the specified performance criteria using prepared Samples as defined using coating materials conforming to the following general requirements:

1). Polyurethane coating material tested shall have been manufactured within 30 days of test Sample preparation.

2). Coating material to have a minimum of 3 years prior pipeline coating application history.

3). Extended polyurethane coatings will not be acceptable.

4). Submission of incomplete reports, use of test procedures or methods other than those specified, or preparation of Samples with a coating material other than those listed will result in rejection of the coating.

5). Reports shall be submitted for review and approval not less than 30 days prior to coating application along with current product data sheets and MSDS sheets for parts A and B.

6). New product formula tests shall be accompanied with Part A and B wet Samples for infrared spectrometry analysis. Wet Samples shall be from the lot and batch tested and shall be collected and sealed by the Engineer for laboratory analysis by the Engineer.

b. Test Sample Preparation:

1). Coating manufacturer to provide 10 days advanced notification of coating Sample preparation for Engineer observation.

2). Failure to fully conform to the preparation requirements will result in rejection of the submitted coating material.

3). Sample preparation completed by the coating manufacturer shall be fully documented and reported to the testing agency by the manufacturer.

4). All coating test Samples shall be prepared in conformance with the following general requirements.

c. Sample Surface Preparation:

1). Method: Abrasive Blast, Green Diamond or Steel Grit, SSPC-SP5, White Metal.

2). Profile: 3.25 mils (plus or minus 0.25 mils), Angular profile, 90 Peak Count per inch minimum, measured and recorded using surface profilometer.

d. Coating Application:

1). Method: Spray film, in accordance with manufacturer's written shop application requirements.

2). Thickness: 35 mils, minimum, 40 mils maximum.

3). Cure: Air cure only, oven or other accelerated cures will not be acceptable.

4). Form: Sheet, steel panel, or steel pipe as required for test procedure.

e. Sample Quantity: Three minimum for each test performed or as required by the ASTM Test Standard, whichever is more stringent.

f. Coating Tests:

1). Testing shall be performed by a certified independent laboratory testing agency with a minimum 5 years' experience in the performance of ASTM test procedures on coating systems.

2). All testing shall be at room temperature, unless specifically required otherwise by the ASTM test procedure.

3). Water Absorption (ASTM D570):

a). Criteria: 1.00 percent, maximum.

b). Method: Long-term Immersion.

c). Sample: Sheet, 1-mm maximum thickness.

4). Permeance (ASTM E96):

a). Criteria: 0.050 inch-pound.

b). Method: Water Procedure BW (App. X1).

c). Conditions: Supported in manner to provide full circulation of air around test container for duration of test procedure.

5). Impact Resistance (ASTM G14):

a). Criteria: 125 inch-pounds, minimum.

6). Cathodic Disbondment (ASTM G95):

a). Criteria: 8 mm, maximum.

b). Potential: -3.00 volts.

c). Duration: 30 days.

d). Radius: Measured from original holiday radius.

7). Adhesion to Steel, Dry (ASTM D4541):

a). Criteria: 3000 psi, minimum.

b). Equipment: Delfesko Positest.

c). Dollies: 20 mm, maximum, scored to metal substrate.

8). Abrasion (ASTM D4060):

a). Criteria: 85 mg loss, maximum.

b). Conditions: CS-17 wheel, 1000 grams weight, 1000 revolutions.

9). Tensile Strength (ASTM D412):

a). Criteria: 4000 psi, minimum.

10). Hardness, Shore D (ASTM D2240):

a). Criteria: 70, Shore D, minimum.

11). Flexibility (ASTM D522):

a). Criteria: Pass (no cracking).

b). Mandrel Diameter: 3 inches, 180 degrees.

g. Reporting:

1). As required by the ASTM test method, and the following additional information:

a). Sample panel preparation date and identification.

b). Surface preparation method and abrasive.

c). Surface Preparation profile and peak count.

d). Coating lot and date of manufacture.

e). Application spray gun and equipment used.

f). Application temperatures of coating materials and material temperature at the gun, ambient temperature, and panel surface temperature.

2). Include all periodic test data and/or observations for all tested Samples and show all multiple measurements in both table and graph.

3). Show all calculations as required by the ASTM test method.

4). Include digital photographic documentation of all visual assessments, test apparatus, and final panel condition using 4 mega pixels minimum resolution.

5). Submit reports in both PDF and color printed format with photographs in JPEG format.

C. Exterior Coating for Exposed Steel Pipe: All atmospherically exposed or vault piping shall be shop primed with the coating system as specified in Section 09 96 00.01 “High-Performance Coatings.”

2.04 INTERIOR SHOP-APPLIED LININGS

A. Cement Mortar Lining:

1. Clean and cement mortar line steel pipe and fittings in accordance with AWWA C205.
2. Cement: Conform to ASTM C150, Type II.
3. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint. Curing of the linings shall conform to the requirements of AWWA C205.
4. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
5. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.

B. Liquid Applied Epoxy Coating:

1. Provide liquid epoxy primer and lining in all cement mortar lined metallic pipe at insulating joints for a minimum of two pipe diameters on each side of the insulated joint.
2. Epoxy coatings shall be NSF approved coatings suitable for potable water contact in accordance with ANSI/NSF Standards 60 and 61.
3. Epoxy shall be applied over the cement mortar lining where specified for the pipeline lining material.
4. Prepare the cement mortar lining by abrasive blasting to remove all laitance and provide a surface profile.
5. Cement mortar shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing.
6. Mortar lining shall be dry when epoxy lining is applied.

2.05 SPECIALS, FITTINGS, AND CONNECTIONS

A. Coating and lining application for special sections, connections, and fittings for steel or ductile iron pipe shall conform to coating system and application requirements as specified in this Section.

B. Specials, fittings, and connections shall be defined as any pipe section with turnouts for blowoffs, interconnects, any valve, or other appurtenances; tees; crosses; wyes; laterals; manholes; mitered angles or elbows; and pipes which require special fabrication that prevents mechanical production application of the specified coating system from end to end of pipe joint.

C. In addition to the items listed as specials, the following items shall also be considered as specials:

1. Pipe joints with pass through holes.

D. Hand applied tape coatings will not be permitted on any specials, fittings, connections, and elbow fittings.

E. Specials, fittings, and connections shall be externally coated with polyurethane coating system applied from end to end of pipe joint on all specials, fittings, and connections.

2.06 EXTERIOR FIELD JOINT COATING

A. Pipe joints shall be field coated after pipe assembly in accordance with AWWA C216, or AWWA C217, whichever is applicable and as specified herein.

B. Field joint coating shall be compatible with the shop-applied coating system and provided by the same manufacturer or a manufacturer approved by the pipe coating manufacturer.

C. All joints on pipe 24 inches in diameter or greater shall be coated with a heat shrink coating material.

D. Field joint coating materials shall be as follows or an approved equal.

1. Heat Shrink Sleeves:

a. Filler Material:

1). Provide filler material for all push-on, flange, and coupling type joints and at all changes in outside diameter greater than 1/8 inch.

2). Filler material shall adhere to the pipe and heat shrink sleeve. Size and type shall be as recommended by the sleeve manufacturer for type of pipe and joint.

3). Filler mastic for joints subject to weld after backfill shall exceed 500 F melt point temperature.

4). Filler material shall be applied in a manner and thickness that no tenting or voids remain under the heat shrink sleeve.

5). Filler material shall be Polyken 939 filler.

b. Joint Coating:

1). Heat shrink, cross-linked polyolefin wrap or sleeve with a mastic sealant, 85-mil nominal thickness, suitable for pipeline operating temperature, as recommended by the manufacturer.

2). Provide standard recovery sleeve for welded or bell and spigot steel pipe joints. High recovery sleeves shall be provided for flange joints and coupling style joints.

3). Width of heat shrink sleeves shall be overlap existing coating 2 inches minimum.

4). Consideration sleeve shrinkage during installation and joint profile in determining sleeve width required. Overlapping of two or more heat shrink sleeves to achieve the necessary width on pipe joints will not be permitted without Engineer approval.

5). Sleeve shall meet requirements for “Weld After Backfill” when allowed and approved by Engineer.

c. Holdback Primer: Per the specified coating system.

d. Heat Shrink Outer Sleeve: SFL Covalence WaterWrap.

2. Wax Tape Coating:

    a. Apply coating in accordance with AWWA C217, except as modified herein.

    b. Wax tape coatings shall be field applied on all buried flexible joints, thrust restraint rods and brackets, and on joints, fittings, or irregular shapes or complex configurations that are not suited for the use of heat shrink coating system.

    c. Do not use wax tape coating systems on vault piping, atmospherically exposed piping and appurtenances, or where subject to UV exposures.

    d. Provide filler material to fill and smooth all irregular surfaces, such that no tenting or voids remain under the applied wax tape.

    e. Use sand backfill to protect wax coating from damage.

    f. Coating System:

        1). Surface Preparation: SP11 Power Tool to Bare Metal.

        2). Primer: Petroleum or petrolatum wax.

        3). Filler Material: Filled Petroleum or petrolatum wax.

        4). Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40 mils thick.

        5). Outer Wrap: PVC or tape suitable for application to inner tape.

        6). Wax tape coating system shall be as manufactured by:

            a). Denso North American Inc., Houston, TX.

            b). Trenton Corporation, Ann Arbor, MI.

            c). Or approved equal.

2.07 FIELD-APPLIED INTERIOR JOINT LINING

A. Mortar Lining:

1. Pipe joints shall be field coated after pipe assembly in accordance with AWWA C602.

2. Field-applied joint lining shall be compatible with the shop-applied lining system and provided by the same manufacturer or a manufacturer approved by the shop-applied lining manufacturer.

3. After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. Excess shall be removed.

4. At no point shall there be an indentation or projection of the mortar exceeding 1/16 inch.

5. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

2.08 REPAIR OF COATINGS AND LININGS

A. General:

1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system and shall be approved by the coating or lining manufacturer.

2. All major repairs on pipe greater than 24 inches in diameter or coated with polyurethane coating system shall be repaired using heat shrink sleeves as specified for field joint coating in accordance with AWWA C216, except as modified herein.

3. Minor coating repairs for polyurethane coated or exposed pipe shall be as specified herein.

B. Coating Repair Materials:

1. Heat Shrink Sleeves (Major Repair):

a. Filler Mastic: Provide mastic filler to fill tape void as required.

b. Full Wrap Coating: Cross-linked polyolefin wrap with a mastic sealant, 85-mil thickness nominal, suitable for pipeline operating temperature, sleeve material recovery as recommended by the manufacturer. Sleeve length shall provide a minimum of 3 inches overlap onto intact pipe coating.

c. Manufacturers: SFL Covalence WaterWrap.

2. Heat-Applied Patches (Minor Repair):

a. Heat applied adhesive, polyolefin backed, mastic coated tape, 12 inches maximum size.

b. Patch shall provide a minimum of 2 inches overlap onto intact pipe coating; except for “Pritec” coated pipe shall have a minimum overlap of 3 inches in the circumferential direction.

c. Manufacturers: Covalence PERP patch.

C. Polyurethane Coating:

1. Polyurethane coating system repair shall be in accordance with the coating manufacturer’s recommended procedures.

2. Coating material for minor repairs shall be single-use kits or other mix ratio-controlled packages of slow set polyurethane coating material similar to the existing coating.

3. Major repairs will be completed using the coating material specified for the coating or the lining. Coating shall be reapplied using plural component spray equipment by a manufacturer certified coating applicator.

4. Pinhole holidays or adhesion test coating repairs shall be with minor repair coating material specified or melt stick repairs, such as Denso-Protal 7125 fast cure epoxy.

D. Exposed Pipe Coating System: Touch-up repair all damage to the primer and/or intermediate coats with the specified coating system prior to final coating of the pipeline in accordance with Section 09 96 00.01 “High-Performance Coatings.”

3.00 EXECUTION

3.01 ENVIRONMENTAL LIMITATIONS

A. General:

1. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
2. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
4. Do not apply coatings when:
    a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the coating manufacturer or the Specifications.
    b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
    c. For epoxy coatings or linings when it is expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
    d. Whenever relative humidity exceeds 85 percent for polyurethane coating application.
5. Where weather conditions or Project requirements dictate, Contractor shall provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturer's coating application recommendations.
6. Work activities can be restricted by the Engineer until adequate temperature and humidity controls are in place and functioning within the environmental limits specified.
7. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.

B. Temperature Control:

1. In cold weather or if moisture collects on the pipe, preheat pipe to a temperature between 45 and 90 degrees or 5 degrees above dew point, whichever is greater.
2. When temperatures are above or below the coating manufacturer's recommended application temperatures, the Contractor will provide temperature controls as necessary to permit Work to precede within the manufacturer's temperature limitations.
3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.

4. Heating shall be with indirect fired heaters that do not increase humidity levels within the work area. Heaters shall be sized for the area to be heated.

C. Dehumidification and Ventilation:

1. Contractor shall provide dehumidification equipment when necessary for shop or field environmental control during surface preparation and/or coating application. Dehumidification equipment shall be properly sized to maintain dew point temperature 5 degrees or more below surface temperature of metal surfaces to be cleaned and coated.
2. Cleaned metal surfaces shall be prevented from flash rusting throughout the Project duration, condensation or icing shall be prevented throughout surface preparation and coating application.
3. Equipment size and power requirements shall be designed by personnel trained in the operation and setup of dehumidification equipment based on Project requirements and anticipated weather conditions.
4. Dehumidification equipment shall operate 24 hours per day and continuously throughout surface preparation and coating application.
5. Contractor to provide personnel properly trained in the operation and maintenance of the dehumidification equipment or provided training by the dehumidification equipment Supplier.
6. Daily environmental condition monitoring and maintenance requirements of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.
7. Reblasting of flash rusted metal surfaces or removal of damaged coatings, because of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor.
8. If the required environmental conditions cannot be maintained throughout the coating process, the Installation Contractor shall provide the following:
    a. Desiccant dehumidification equipment to maintain environmental conditions 24 hours a day during abrasive blasting, coating application and cure. Liquid, granular or loose lithium chloride drying systems will not be acceptable.
    b. Ventilation within the environmentally controlled areas shall meet the following requirements:
        1). Two air exchanges per hour, minimum.
        2). Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the Work.
        3). Maintenance of personnel exposure limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the Work.

3.02 SURFACE PREPARATION

A. General:

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of coating manufacturer whose product is to be applied.

2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.

3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.

4. Protect prepared pipe from humidity, moisture, and rain. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by reblasting.

5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation:

1. Requirements: Spray applied coating systems do not require weld grinding.

C. Steel Surface Preparation:

1. Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness specified for the coating system to be applied or as specified herein, whichever is more stringent.

2. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified.

3. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.

4. Polyurethane coating system shall have a sharp angular surface profile of the minimum depth specified.

5. Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust.

6. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at the Engineer's sole discretion.

3.03 SHOP -APPLIED COATING SYSTEMS

A. Polyurethane Coating or Lining:

1. Applicator Qualifications:

a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.

b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.

c. Personnel responsible for the application of the coating system shall have certification of attendance at the coating manufacturer's training class within the last 3 years. The certified applicator shall be present during all coating application Work and shall have responsibility for controlling all aspects of the coating application.

2. Pipe surface temperature shall be between 50 and 100 F or 5 F above dew point, whichever is greater.

3. Coating application shall be performed in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer. Application in outdoor conditions will not be acceptable without adequate environmental shelter, environmental controls, and/or dehumidification.

4. Coating adhesion and holiday testing shall be tested as specified in this Section.

5. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

6. Unacceptable Coating Application:

   a. Coating applied under improper environmental conditions will be rejected.

   b. Pipes that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected.

   c. Coating which fails the adhesion or holiday testing as specified in this Section shall be rejected.

   d. Pipe coating that is subject to off ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.

7. Rejected coating shall be removed from the full length of the pipe to bare metal and reapplied using proper application methods in accordance with the quality assurance manual and the requirements of the Contract Documents.

8. Perform coating and lining repairs as specified in this Section.

3.04 EXTERIOR COATING HOLDBACK

A. Coating holdbacks shall be straight and cut through the full thickness of the coating.

B. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

C. Holdbacks shall be as required for proper jointing of pipe, considering joint welding requirements, and be as follows:

Holdbacks	
Push-on joint, spigot	1 inch before centerline gasket
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	4-inches, minimum

D. Dielectric Coating Holdback Corrosion Protection:

1. Holding primer for corrosion protection of cutbacks or holdbacks shall be compatible with the specified joint coating system and weld after backfill requirements, when applicable.
2. Approved holdback primers are:
    a. Tnemec Omnithane: Suitable for all joints, except joints subject to weld after backfill.
    b. Tnemec 90E-92 Ethyl Silicate Inorganic Zinc-Rich Primer: Suitable for all joints, including weld after backfilling joints.
    c. ICI Devoe Cathacoat 304V Ethyl Silicate Inorganic Zinc Primer: Suitable for all joints including weld after backfilling joints.
    d. Polyken or Other Tape Primers: Not allowed.
3. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during weld after backfilling operations.
4. Application and thickness of holding primer shall be in accordance with the coating manufacturer's recommendations but shall not impair the clearances required for proper joint installation.
5. Primer application on spigot end of field welded pipe shall be held back 1 to 2 inches from the end of the spigot or as necessary to prevent toxic fumes during field welding.
6. Any corrosion within the holdback areas shall be abrasively blasted to near white metal in accordance with SSPC-SP10 or power tool cleaned to bare metal in accordance with SSPC-SP11 prior to applying joint coating.

3.05 PIPE LINING APPLICATION

A. Shop-applied Cement Mortar Lining:

1. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
2. Steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-by-4-inch No. 13 gage welded steel wire mesh.
3. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.

4. Tightly close ends of pipe and fittings with plastic sheet caps. Plastic end caps shall be of thickness and strength to resist shipping, handling, and storage stresses.

5. Damage to the cement mortar lining, including disbondment, cracking, or blistering, caused by improper curing, shipping, handling, or installation shall be repaired in accordance with AWWA specifications and to the satisfaction of the Engineer.

6. Other requirements of mortar lining materials and processes: As specified in AWWA C205.

B. Liquid Epoxy Lining:

1. Clean and coat the interior of cement mortar lined pipe at insulating joints or where specified with two coats of epoxy coating.

2. Epoxy coating applied at insulating joints shall be applied to both sides of the insulating joint for a minimum of one pipe diameter. If only one side of the joint can be coated the coating shall be applied for a minimum of two pipe diameters.

3. Mortar lining shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and epoxy coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement or concrete, whichever is greater.

4. Prepared mortar lining by abrasive blasting to remove all laitance and create a suitable anchor profile.

5. Epoxy coating shall be applied in two coats minimum, at a total coating thickness of 16 mils dry film thickness. Coating applied over cement mortar lining shall be applied in a manner that will minimize gassing and pinholes in the completed lining.

6. Mortar lining shall be dry during epoxy lining application.

3.06 FIELD COATING JOINTS

A. General:

1. Remove all oil or grease contamination by solvent wiping the pipe and adjacent coating in accordance with SSPC-SP1, Solvent cleaning.

2. Clean pipe surface and adjacent coating of all mud, corrosion, and other foreign contaminates in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal or abrasive blast joints in accordance with SSPC-SP10, near white metal blast, that exhibit any surface corrosion or staining. When required, clean the full circumference of the pipe and a minimum of 6 inches onto the existing coating.

3. Remove all loose or damaged pipe coating at joint and either repair the coating as specified herein or increase the length of the joint coating, where reasonable and practical.

4. Complete joint bonding of pipe joints before application of joint coating. Joint bonds shall be installed as specified in Section 13 47 13 "Cathodic Protection." Joint bonds shall be low profile bonds and all gaps and crevices around the bonds shall be filled with mastic sealant.

5. Contractor to electrically test completed joint coating for holidays with high voltage spark tester.

B. Weld After Backfill Joint Requirements:

1. Post-welded or 'Weld after Backfill' joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.

2. Post welded joints shall be coated and protected as follows:

   a. Joint coating shall be SFL Covalence WaterWrap heat shrink joint sleeves only. Tape wrapped joints will not be acceptable.

   b. Hold back primer shall be suitable for post weld conditions as specified in this Section and shall not exhibit any binder breakdown in the heat effect zone that causes loss of joint coating adhesion to the holdback primer.

   c. Filler mastic materials shall be high temperature materials with 500 F melting point.

   d. Joints shall be fully buried prior to welding, with not less than 36 inches cover of soil or flowable fill material on all sides. Sand or flowable fill backfill is preferred for weld after backfilling joints.

3. Welding of the joints shall be in conformance with the Specification 33 11 13.13 "Steel Pipe and Fittings" and as modified herein:

   a. All welding shall be with stick electrodes and two or more weld passes as required to meet the specified AWS qualified welding procedures and maximum coating temperature limitations. 'Weld after Backfill' procedures on wall thicknesses of 1/4 inch or less must be approved by the Construction Manager based on field testing demonstrating the welding procedures can comply with the requirements of this Section.

   b. Welding speed, amperage, and voltage shall be as required to maintain a maximum heat input of 23,000 joules or a maximum surface temperature at the coating/steel interface of 800 F, whichever is least.

   c. Maximum weld temperature and duration shall not result in carbonization of the joint coating adhesive. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.

   d. Finished joint coating shall not have any visual creases or folds in the joint coating backing material that extends through both the inner protective layer and outer joint sleeve.

4. If Contractor elects to post-weld any joints, Contractor shall demonstrate that the joint welding procedures will not significantly damage the coating by fully excavating the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation by Contractor for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Contractor will remove and replace joint heat shrink sleeve upon completion of the evaluation.

5. If any excavated post welded joint exhibits any heat related damage as defined herein, Contractor shall modify and test a new post welding procedure prior to completing any

additional post-welded joints. Contractor shall demonstrate that the revised joint welding procedure will not significantly damage the coating by repeating the weld after backfill evaluation requirements defined in this Section, including excavation of the three additional randomly selected joints for destructive evaluation.

C. Heat Shrink Sleeve Joint Coating:

1. Store, handle, and apply field heat shrink sleeve coatings in accordance with AWWA C216 and this Section.
2. Store sleeves in shipping box until use is required. Keep dry and sheltered from exposure to direct sunlight. Store off the ground or concrete floors and maintain at a temperature between 60 and 100 degrees as recommended by the sleeve manufacturer.
3. Metal surface shall be free of all dirt, dust, and surface corrosion prior to sleeve application. Surface preparation shall be in accordance with the joint coating manufacturer's recommendations.
4. Where corrosion in the holdback area is visible, surfaces shall be prepared in accordance with SSPC-SP10, near white metal blast, or SSPC-SP11, power tool cleaning to bare metal.
5. Preheat pipe uniformly as recommended by the sleeve manufacturer. Monitor pipe temperature using a surface temperature gauge, infrared thermometer, or color changing crayons. Protect preheated pipe from rain, snow, frost, or moisture with tenting or shields and do not permit the joint to cool.
6. Fill all cracks, crevices, gaps, and step-downs greater than 1/4 inch with filler mastic in accordance with the manufacturer's recommendations for the full circumference of the pipe.
7. Apply heat shrink sleeve when it is at a minimum temperature of 60 degrees and while maintaining the pipe temperature above the preheat temperature specified. Apply sleeve in accordance with the manufacturer's instructions and center the sleeve over the joint to provide a minimum 2-inch overlap onto the existing pipe coating.
8. Completed joint sleeve shall be fully bonded to the pipe and existing coating surface without voids. Mastic beading shall be visible along the full circumference of the sleeve. There shall be no wrinkling or excessive burns on the sleeves. Sleeves that do not meet these requirements shall be removed and the joint recoated as directed by the Engineer. Minor repairs may be repaired using heat applied patch material specified for minor coating repairs.
9. Allow the sleeve to cool before backfilling. In hot climates, provide shading from direct sunlight. Water quenching will be allowed only when permitted by the sleeve manufacturer.
10. Heat shrink joint coatings which have become wrinkled or disbonded because of prolonged exposure to UV light or thermal cycling shall be removed and replaced.
11. Double coating of defective or damaged heat shrink coatings will not be permitted. Any double coated heat shrink sleeves shall be immediately rejected and Contractor shall remove and recoat the joint.

3.07 REPAIR OF COATING AND LININGS

A. General:

1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected but are visually damaged shall also be repaired.
2. Maximum allowable defects shall be as specified herein for the coating system.

B. Polyurethane Coating or Lining Repairs:

1. General:
    a. Complete coating or lining repairs in accordance with the coating manufacturers written instructions and this Section, whichever is stricter.
    b. Defect Size:
        1). Minor repairs: Repairs that are less than 6 inches in the greatest dimension.
        2). Major repairs: Repairs that exceed 6 inches in the greatest dimension.
    c. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated.
    d. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.
2. Maximum Quality of Defects Allowed:
    a. Coating or lining repairs on any joint of pipe shall not exceed 1.5 per 100 square feet of surface area.
    b. Two or more minor repairs within 6 inches diameter circle will be considered a single repair.
    c. Repairs for adhesion testing will not be included in the total number of repairs.
    d. Minor repairs:
        1). Surface Preparation: Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2 inches around the defect.
        2). Shop Repair Materials:
            a). Slow setting parent material polyurethane coating material in syringes or other single use packaging that controls mix ratio.
            b). Coating manufacturer's polyurethane coating repair products subject to Engineer's approval.
        3). Field Repair Materials:
            a). Melt stick coating repair (not acceptable for repairs greater than 1-inch diameter); 3M Scotchkote 226P, Canusa-CPS Melt Stick, or approved equal.
            b). Heat applied coating materials or approved equal.

c). Coating manufacturer's polyurethane coating repair products subject to Engineer's approval.

4). Apply a single coat of the specified patch coating material at the specified coating thickness.

5). Repaired adhesion shall be 50 percent of the specified coating adhesion.

3. Major Repairs:

a. Major repairs shall not exceed two per pipe joint and the combined area shall not be greater than 50 percent of the pipe.

1). The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation.

2). Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.

b. Shop Repair Materials: Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.

c. Field Repair Materials:

1). Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.

2). Heat shrink sleeves as specified for pipeline joints.

d. One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness.

e. Repair adhesion shall be equal to the specified coating adhesion.

C. Cement Mortar Coating or Overcoat:

1. Cement mortar coating that is cracked or disbonded shall be repaired in accordance with AWWA C205, except for mortar overcoat or dielectric steel.

2. Disbonded coating with disbondment greater than 25 percent of the pipe surface shall be rejected and recoated.

3.08 INSPECTION AND TESTING

A. General:

1. Applicator shall inspect and test the coating system in accordance with referenced standards and this Section, whichever is more stringent.

2. The frequency of the testing shall be determined by the applicator but shall not be less than the requirements of this Section.

3. Owner or Owner's representative will conduct random independent inspections and tests for the final acceptance or rejection of pipe coating or lining.

4. Installation Contractor to preform holiday testing in the field using equipment provided as specified in Paragraph **[2.02]**. Tests will be completed in the presence of the Owner's

representative on each joint of pipe and fitting once the pipe has been lifted to be lowered into the trench. Holidays shall be repaired as specified.

B. Adhesion Testing:

1. General:

a. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of the Contractor.

b. A minimum of two pipes will be tested for adhesion from each lot of pipe coated up to 3000 square feet of pipe. An additional adhesion test will be conducted on every increment up to 2000 square feet of pipe coated in excess of the first 3000 square feet of pipe. (i.e. if one workday of production is 6000 square feet of pipe, four adhesion tests will be conducted on the pipe lot.) Adhesion testing shall be conducted on not less than 50 percent of each pipe produced within a lot.

c. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a work shift, but not to exceed 12 hours.

d. The pipe coating applicator shall repair all coating damage from shop adhesion testing. Contractor shall be responsible for coating repairs for all field adhesion testing.

e. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24 hours will be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the pipe fabricator.

f. Pipe will be randomly selected for adhesion testing.

g. Owner or the Owner's representative has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets or exceeds the requirements of this Section at any time and location.

2. Rejection of Coating:

3. If any pipe within a lot fails to meet the test criteria specified for the coating type, that pipe shall be rejected along with all other pipes within the lot. Each pipe within the rejected pipe lot will then be individually tested and rejected on a pipe-by-pipe basis in conformance with the test procedures and criteria specific for the coating type.

4. All rejected pipe shall have all coating removed from the full-length pipe and the pipe abrasive blasted and recoated.

5. Polyurethane Adhesion Testing:

a. Acceptance Criteria:

1). Polyurethane coating or lining shall have an adhesion to steel of 1750 pounds per square inch, minimum. Acceptance will be based on one pull minimum, with no pulls less than the minimum criteria where multiple pulls are conducted on the same joint of pipe.

2). The median value for all coating or lining adhesion pulls performed within a lot of pipe shall not be less than 2000 psi.

3). Each pipe failing the minimum adhesion criteria shall be rejected. AWWA C222 rejection of pipe based on multiple adhesion pulls is specifically excluded from this Section.

4). Pipe lots failing the median value for all adhesion pulls shall be rejected and each pipe within the lot tested for adhesion. Each pipe that fails the adhesion criteria shall be rejected.

5). Failure shall be by adhesive and cohesive failure only. Adhesive failure is defined as separation of the coating from the steel substrate. Cohesive failure is defined as failure within the coating, resulting in coating remaining both on the steel substrate and dolly.

b. Test Procedures:

1). Polyurethane coating adhesion to steel substrates shall be tested using self-aligning pneumatic pull off equipment, such as the Delfesko Positest, and test procedures in accordance with ASTM D4541 and AWWA C222, except as modified in this Section.

2). All adhesion test pull records shall be maintained in an electronic spreadsheet that includes pipe identification, pipe coating date, adhesion test date, surface tested (interior or exterior), surface temperature, coating thickness, tensile force applied, rate of pressure change per second, mode of failure, and percentage of substrate failure relative of dolly surface.

3). Dollies for adhesion testing shall be 20 millimeters in diameter, glued to the coating surface and allowed to cure for a minimum of 12 hours before testing.

4). Polyurethane coatings shall be scored around the dolly prior to conducting the adhesion test. Scoring shall be completed manually, normal to the pipe surface, or in a manner that does not stress or overheat the coating.

5). Adhesion testing shall be performed at temperatures between 55 and 100 F. Tests may be performed at temperatures up to 115 F if no significant affect in the test results are statistically detectable.

6). Partial substrate and glue failures will be retested if the substrate failure is less than 50 percent relative of the dolly surface area and the applied tension was less than the specified adhesion. Pipes that have partial substrate failures greater than 50 percent and less than the specified adhesion will be rejected as a substrate adhesion failure.

7). Glue failures in excess of the minimum required tensile adhesion would be accepted as meeting the specified adhesion requirements.

8). If multiple adhesion pulls on the same pipe are performed, adhesion pulls shall be performed in a circumferential direction with all pulls in a straight line and within an area 1-1/2 inches in width and spacing between dollies between 1 and 2 inches.

9). Adhesion tests will be conducted on polyurethane pipe coating and lining independently and will be accepted or rejected independently of the other.

c. Adhesion Test Repairs:

1). Repair patches on the polyurethane coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the coating inspector conducting the adhesion tests. Adhesion of repairs shall be as specified for the type of repair.

C. Holiday Testing:

1. Holiday tests on polyurethane coatings, linings or heat-shrink sleeves will be conducted on the completed coating or lining after cure or 24 hours, whichever is less, using a high voltage spark test in accordance with NACE Standard SP0274 and the Specifications.

2. Coating thickness used for holiday testing shall be the minimum specified coating thickness.

D. Dry Film Thickness Testing:

1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off or eddy current equipment.

2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this Section.

3.09 HANDLING, TRANSPORTATION, AND STORAGE

A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be shipped or installed until coating has developed full adhesion and cure.

C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have all bearing surfaces padded with suitable padding material. Lift pipe with web slings a minimum of 12 inches wide and of a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the Site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sandbags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.

F. Pipe shall be inspected by the Contractor at the Site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when absolutely necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure: Pipe shall either be provided with UV inhibitor for lengthy above grade exposure or covered to prevent UV degradation of outer wrap. Amount of UV stabilizers required will depend on the Project location, laying schedule, anticipated length of exposure, and type of outer wrap. Manufacturer shall be consulted for recommended UV inhibitors requirements or pipe shall be stored under a protective cover. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable. Areas of coating that display UV degradation shall be removed and repaired at sole cost of the Contractor.

I. End Caps: Pipe ends of mortar lined pipe and fittings shall be tightly closed with a plastic wrap to aid in curing and to minimize drying out of and contamination of the lining. Plastic end cap shall consist of a minimum of one 10-mil sheet of polyethylene or other suitable material. End caps shall be substantial enough to resist shipment, handling, and storage loads and firmly attached in place. The plastic end cap shall remain intact and in place until pipe installation. Damaged or missing plastic end caps shall be repaired or replaced.

J. Bracing:

1. The steel pipe manufacturer shall furnish and install adequate bracing or strutting to keep the pipe from becoming deformed, or damage from occurring to the coating or linings. Strut-type bracing shall be installed as soon as possible after application of lining. Struts shall remain in place during handling, storage, transportation and installation of pipe and fittings until after the pipe zone material is compacted.

2. The struts shall be installed with pads and wedges in such a manner that the pipe lining will not be damaged and the struts will not be dislodged during shipping and handling of the pipe. If struts are welded, they shall be installed and removed in such a manner to prevent damage to the steel cylinder, lining or coatings. All damage shall be repaired to the satisfaction of the Engineer.

END OF SECTION

10 43 10 SIGNS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Panel signs.
2. Signage accessories.

B. Related Sections include the following:

1. Division 23 Section "Mechanical Identification" for labels, tags, and nameplates for mechanical equipment.
2. Division 26 Section "Electrical Identification" for labels, tags, and nameplates for electrical equipment.
3. Division 26 Section "Lighting" for illuminated exit signs.

1.03 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.

B. Samples for Initial Selection: For each type of sign material indicated that involves color selection.

C. Samples for Verification: For each type of sign, include the following Samples to verify color selected:

1. Panel Signs: Full-size Samples of each type of sign required.
2. Approved samples will be returned for installation into Project.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain each sign type through one source from a single manufacturer.

B. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions of the Texas Department of Licensing and Regulation (Texas Accessibility Standards).

1.05 COORDINATION

A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.

1. For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 PANEL SIGNS

A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

B. Available Manufacturers:

1. Takeform Architectural Graphics
2. American Graphics Inc.
3. Andco Industries Corp.
4. APCO Graphics, Inc.
5. ASI Sign Systems, Inc.
6. Best Manufacturing Co.
7. Multi-graphics, Incorporated, Pelham, Ga.
8. Mohawk Sign Systems.
9. Seton Identification Products.
10. Signature Signs, Inc.

2.03 PANEL SIGN TYPES

A. Room Signs: Room ID w/ Small Insert F21-B-D1; Standard Room I.D. F21-B-BH;

1. Manufacturer: Takeform Architectural Graphics
2. Series: Fusion 21
3. Material: Laminate Sheet.
4. Metal Accent Bar/ Hardware: Bronze
5. Perimeter: Unframed.
6. Copy: Tactile and Braille.
7. Character Style: Meta Bold MB101
8. Character Color: CO402 Espresso

9. Text: As indicated in the Sign Schedule.
10. Message: Changeable
11. Sizes:
    a. Sign: 7.88” X 9.94” (F21-B-D1); 4.75” X 9.5” (F21-B-BH);
    b. Character: Minimum 1-inch high characters.
12. Colors: To be selected

2.04 ACCESSORIES

A. Vinyl Film: Provide opaque nonreflective vinyl film, 0.0035-inch (0.089-mm) minimum thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.

B. Mounting Methods: Use double-sided vinyl tape fabricated from materials that are not corrosive to sign material and mounting surface.

C. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.05 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items, including anchor inserts, provided under other sections of Work are sized and located to accommodate signs.

C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious mat-ter.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using methods indicated below:

1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.

3.03 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

3.04 SIGN SCHEDULE:

A. Interior and Exterior Signs

1. As shown on drawings.

END OF SECTION

10 44 16 FIRE EXTINGUISHERS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes portable, hand-carried fire extinguishers, cabinets and mounting brackets for fire extinguishers.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.04 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.

b. Faulty operation of valves or release levers.

2. Warranty Period for fire-extinguishers: 6 years from date of Substantial Completion.

2.00 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, “Portable Fire Extinguishers.”

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Amerex Corporation.
    b. Ansul Incorporated; Tyco International Ltd.
    c. Badger Fire Protection; a Kidde company.
    d. J. L. Industries, Inc.; a division of Activar Construction Products Group.
    e. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
    f. Larsen's Manufacturing Company.
    g. Pyro-Chem; Tyco Safety Products.
2. Valves: Nickel-plated, polished brass body.
3. Handles and Levers: Stainless steel.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix.

B. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated 2-A:10-B:C, 5-lb. (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Amerex Corporation.
    b. Ansul Incorporated; Tyco International Ltd.
    c. Badger Fire Protection; a Kidde company.
    d. Buckeye Fire Equipment Company.
    e. Fire End & Croker Corporation.

f. J. L. Industries, Inc.; a division of Activar Construction Products Group.

g. Larsen's Manufacturing Company.

h. Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location if extinguisher is not in a cabinet. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical..

3.00 EXECUTION

3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

23 00 00 HEATING, VENTILATING, AND AIR CONDITIONING

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Equipment installation requirements common to equipment sections.
2. Painting and finishing.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 QUALITY ASSURANCE

A. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing; connecting electrical services, circuit breakers, and conduit sizes are appropriately modified; and all is provided at no additional cost. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.05 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

3.00 EXECUTION

3.01 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.02 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

END OF SECTION

23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Duct markers.
5. Warning tags.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

2.00 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

    a. Name and plan number.

    b. Equipment service.

    c. Design capacity.

    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches (64 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

C. Equipment Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: 1/16 inch (1.6 mm) for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3.2 mm) for larger units.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

3.00 EXECUTION

3.01 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 to 3/4 the size of principal lettering.

2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
    a. Fire department hose valves and hose stations.
    b. Meters, gages, thermometers, and similar units.
    c. Fans, blowers, primary balancing dampers, and mixing boxes.
    d. Packaged HVAC central-station and zone-type units.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
    1. Identify mechanical equipment with equipment markers in the following color codes:
        a. Green: For cooling equipment and components.
        b. Yellow: For heating equipment and components.
        c. Green and Yellow: For combination cooling and heating equipment and components.
        d. Brown: For energy-reclamation equipment and components.
    2. Letter Size: Minimum 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 to 3/4 the size of principal lettering.
    3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3.03 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.04 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

1.00 GENERAL

1.01 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

a. Constant-volume air systems.

2. HVAC equipment quantitative-performance settings.

3. Verifying that automatic control devices are functioning properly.

4. Reporting results of activities and procedures specified in this Section.

1.02 SUBMITTALS

A. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit four copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

C. Warranties specified in this Section.

1.03 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," as applicable.

1.04 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.05 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.06 WARRANTY

A. National Project Performance Guarantee: If AABC, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: If NEBB, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine equipment for installation and for properly operating safety interlocks and controls.

M. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.

9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," as applicable, and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Owners Representative for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes at no additional cost.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR HEAT-TRANSFER COILS

A. Electric-Heating Coils: Measure the following data for each coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Refrigerant Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.07 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.08 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.09 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.

2. Air Outlets and Inlets: 0 to minus 10 percent.

3.10 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Fan curves.

2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect/Engineer's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Balancing stations.
4. Position of balancing devices.

END OF SECTION

23 81 13 WALL-MOUNT AIR-CONDITIONERS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes packaged terminal air conditioners and their accessories and controls, in the following configurations:

1. Vertical wall-mount.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Show installation details for wall penetrations.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: Include emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged terminal air conditioners and are based on the specific system indicated. Refer to Section 01 60 00 "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.05 COORDINATION

A. Coordinate layout and installation of packaged terminal air conditioners and wall construction with other construction that penetrates walls or is supported by them.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than **5** years from date of Substantial Completion, including components and labor.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bard Manufacturing Co.
2. Marvair.

2.02 MANUFACTURED UNITS

A. Description: Factory-assembled and tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil.

1. Power Supply: Cord-connected chassis for 460V units.

B. Cabinet: 0.052-inch (1.32-mm) thick, galvanized steel with removable front panel with concealed latches.

1. Mounting: Exterior wall with wall sleeve.
2. Finish: Baked enamel.
3. Grilles: Extruded-aluminum supply and return grilles.
4. Wall Sleeves: Galvanized steel with polyester finish.

C. Refrigeration System: Direct-expansion indoor coil with capillary restrictor, hermetically sealed scroll compressor with internal spring isolation, external isolation, permanent-split-capacitor motor, and overload protection. Include the following:

1. Outdoor coil and fan.

D. Indoor Fan: Forward curved, centrifugal, with permanent-split-capacitor motor and positive-pressure ventilation damper with electric operator.

1. Motor:

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Noise Rating: Quiet.

c. Electrical devices and connections are specified in Division 26 Sections.

E. Filters: Aluminum frame MERV 8 filters.

F. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

G. Condensate Drain: Drain pan and piping to direct condensate to an approved place of disposal.

H. Outdoor Fan: Forward curved, centrifugal type driven by indoor fan motor.

1. Motor:

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Noise Rating: Quiet.

c. Electrical devices and connections are specified in Division 26 Sections.

2.03 CONTROLS

A. Thermostat: Wall-mounted adjustable, 7-day programmable temperature controller. Microcomputer based with automatic changeover from cooling to heating. One stage cool, one stage heat.

2.04 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

B. Unit Performance Ratings: Factory test to comply with ARI 310/380, "Packaged Terminal Air-Conditioners and Heat Pumps."

3.00 EXECUTION

3.01 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 07 92 00 "Joint Sealants."

C. Install wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.02 CONNECTIONS

A. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

B. Ground equipment according to Division 26.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. After installation, verify the following:

1. Unit is level on base and is flashed in exterior wall.
2. Unit casing has no visible damage.
3. Compressor, air-cooled condenser coil, and fans have no visible damage.
4. Labels are clearly visible.
5. Controls are connected and operable.
6. Shipping bolts, blocks, and tie-down straps are removed.
7. Filters are installed and clean.
8. Drain pan and drain line are installed correctly.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions, including the following:

1. Lubricate bearings on fan.
2. Check fan-wheel rotation for correct direction without vibration and binding.

E. After startup service and performance test, change filters.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged terminal air conditioners.

END OF SECTION

26 01 26 TESTING OF ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, material, equipment and incidentals of an independent testing agency. Testing shall be inclusive of all medium voltage and low voltage equipment including conductors for the project at the locations listed below. Testing shall include all relay and breaker protective schemes and operation of the medium and low voltage equipment.

Location
Collier's Ferry Raw Water Pump Station

1.02 QUALITY ASSURANCE

A. Independent testing agency shall follow all tests and recommendations in NETA Acceptance Testing Specification for all equipment provided.

B. Acceptable Testing Agencies:

1. National Field Services
2. Real Power Technologies
3. Shermco Industries
4. No others shall be accepted

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, "Document Management " and shall include:

1. ELECTRICAL QUALIFICATIONS & LIST OF TEST SUBMITTAL
    a. 60 days prior to any testing taking place, Contractor shall submit to the Owner/Engineer the name of the testing agency; a list of all tests to be conducted shall also be submitted at this same time. No testing shall take place until this has been submitted and approved by the Engineer.
2. ELECTRICAL TESTING PLAN
    a. A minimum of two (2) weeks before testing is to take place, Contractor shall submit a detailed testing plan of the different configurations to be tested for the Owner's and Engineer's approval.
3. ELECTRICAL TESTING REPORT
    a. A written report shall be submitted by the testing agency performing installation checks, operation and testing of the medium and low voltage equipment. This report shall certify that
        1). The equipment has been properly installed,

2). Is in accurate alignment, and

3). Meets the acceptance testing specifications of NETA and the equipment manufacturer.

4). Provide a detailed list of all tests that were performed and the test results as part of the Electrical Testing Report.

5). Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

6). Provide a detailed list of megger results for low voltage cables. List should include circuit tag as shown on the contract documents, voltage, phase and cycle identification, phase-to-phase result for each combination of phases, phase-to-neutral result for each combination of phase and phase-to-ground result for each combination of phases. List should also include person's witnessing and performing tests.

7). Infrared test results shall include the following for each item tested:

a). A description of the equipment tested

b). The load (in amps) and operating conditions at which the equipment was running and other testing conditions that may affect the IR results

c). A thermal image alongside a standard photograph. An image shall be included for each thermal image taken for the project.

d). Where issues are identified by thermal image, provide a photograph with annotation indicating where problems are detected.

e). A description of any problems detected

f). Information on the camera listing model number, processor type, date of last calibration, resolution, etc.

b. Electrical Testing Report shall be submitted to the Engineer for approval at least four(4) weeks before start-up and training and no later than four weeks after testing has been conducted. The Contractor shall not be allowed to wait for the final test to be performed to submit a single testing report. Individual test reports may be submitted to maintain the maximum of four weeks after test has been performed.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI)
2. American Standards for Testing and Materials (ASTM)
3. Institute of Electrical and Electronic Engineers (IEEE)
4. National Electrical Manufacturers Association (NEMA)
5. International Electrical Testing Association (NETA)

1.05 RELATED SPECIFICATIONS

A. All testing referenced in the following Specifications shall be submitted under this section:

1. 26 05 19, “Low Voltage Electrical Conductors & Cables”
2. 26 05 23, “Control-Voltage Electrical Power Cables”
3. 26 05 26, “Grounding & Bonding for Electrical Systems”
4. 26 22 13, “Low Voltage Distribution Transformers”
5. 26 14 13, “Low Voltage Switchboards”
6. 26 29 23.11, “Low Voltage Variable Frequency Drives”
7. 26 32 13, “Engine Generators”
8. 26 36 00, “Transfer Switches”

2.00 PRODUCTS [NOT USED]

3.00 EXECUTION

3.01 GENERAL

A. Perform all testing identified in the latest edition of NETA Standard for Accepting Testing Specifications.

B. All testing shall be witnessed by the Owner’s Representative. Types of equipment required to be tested by these specifications shall include but not be limited to the following:

1. The following tests shall be conducted by the Contractor:
    a. Cables
        1). Low Voltage Cables.
            a). Insulation - resistance test
            b). Perform resistance measurements through all connections with a low resistance ohmmeter.
            c). Perform Continuity test to insure correct cable connection. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
            d). Perform each visual and mechanical inspection and electrical tests stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
            e). Perform all tests as specified in NETA Acceptance Testing Specifications.

f). Perform a thermographic survey of all connections under load conditions for cables #1/0 and larger.

(1). Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No.3 AWG and larger. Remove box and equipment covers so terminations are accessible to portable scanner.

(a). Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each termination 11 months after date of Substantial Completion.

(b). Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

(c). Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

g). Remove and replace malfunctioning units and retest as specified above.

b. Transformers

1). Low Voltage Distribution Transformers

a). Test transformers in accordance with NETA Acceptance Testing specifications. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

(1). Applied Potential;

(2). Induced Potential;

(3). No Load Losses;

(4). Voltage Ratio;

(5). Polarity;

(6). Continuity

b). Manufacturer shall perform the following additional tests on units identical to the design type being supplied to this specification. Manufacturer shall provide on request test data sheets to prove performance of these tests.

(1). Sound Levels

(2). Temperature Rise Tests

(3). Full-Load Losses

(4). Regulation

(5). Impedance

c. Low Voltage Equipment

1). Low Voltage Variable Frequency Drives

2). Generator

3). Transfer-switch

d. Grounding.

1). Use Biddle Direct Reading Earth Resistance Tester or equivalent to measure resistance to ground of the system. Perform testing in accordance with the test instrument manufacturer's recommendation using the fall of potential method.

2). All test equipment provided under this section shall be approved by the Engineer.

3). Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

4). Testing shall be performed before energizing the distribution system.

5). A separate test shall be conducted for each building or system.

6). Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms. Provide additional ground rods and conductors as required to bring the resistance to five ohms.

7). Submit reports of all tests to the Owner/Engineer.

C. All testing shall be in accordance with the manufacturer's recommendations for energization and start-up of the equipment.

D. Testing shall include a complete functionality testing of electrical equipment under all the different operating parameters identified by the Owner and Engineer.

3.02 POWER SYSTEM TESTING

A. Contractor shall test the operation of the power distribution system, i.e. transformers, 480V Switchboard, and the automatic transfer switch, etc., for the various possible system configurations under load conditions.

B. Testing shall include, but not be limited to the following:

1. 480V ATS at the electrical building.

a. Normal power from Utility Source with a maximum of three (3) Raw Water Pumps plus misc. loads

2. 480V ATS at the electrical building.

    a. Back-up power from Generator with a maximum of three (3) Raw Water Pumps plus misc. loads

C. Contractor shall submit a detailed testing plan of the different configurations to be tested for the Owner's and Engineer's approval.

END OF SECTION

26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary for complete and operational electrical systems, as specified herein.

B. This Section, as well as Division 1, concerns all other Sections in Division 26, and shall be considered a part of each of those Sections as if written in their entirety.

1.02 QUALITY ASSURANCE

A. ELECTRICAL CONTRACTORS' QUALIFICATIONS

1. Use adequate numbers of skilled workmen, trained and experienced in their crafts, and who are familiar with the specifications and methods of performing the work in this Division. A licensed Journeyman shall be on site at all times when electrical work is being performed. Electrical work shall be performed under the direct supervision of a Master Electrician who holds a valid license in the State of Texas. The Contractor shall provide a monthly report to the Owner/Engineer for review stating that the Master Electrician has been to the job site and thoroughly reviewed the work. **THE REPORT SHALL BE SIGNED BY THE MASTER ELECTRICIAN AND INCLUDE THE DATE AND TIME THE MASTER ELECTRICIAN WAS ON SITE. THE REPORT SHALL BE INCLUDED IN THE PAY APPLICATION. NO PAYMENT WILL BE GRANTED WITHOUT REPORT.**

B. WORKMANSHIP

1. Work shall be performed in accordance with quality, commercial practices. The appearance of finished work shall be of equal importance with its operation. Materials and equipment shall be installed based upon the actual dimensions and conditions at the project site. Locations for materials or equipment requiring an exact fit shall be field measured. Conduit, transformers, and motors shall be isolated to avoid unacceptable noise levels from objectionable vibrations from all systems.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management ”, and shall include:

1. Component catalog number and manufacturing data sheet, indicating pertinent data and clearly marked identifying each component by the item number and nomenclature as specified.

2. Submit copy of Master Electrician’s license and each Journeyman’s license that will be working on the project. Workers must be licensed to work in the City where the project is located.

3. Component drawings showing dimensions, mounting, and external connection details.

4. Complete interconnection and point to point wiring diagrams in AutoCAD format for all field control and instrumentation wiring between instruments, electrical equipment, starters, VFDs, etc. A hard copy shall be submitted to the Engineer for approval prior to the final AutoCAD files being submitted. Interconnection/wiring diagrams shall include cable numbers, wire tags, actual equipment terminal strip numbers at both ends of the cable, etc.
5. Operation and maintenance manuals shall contain the approved shop drawings, submittals, spare part lists, schematics, final wiring diagrams with any changes made during start-up and maintenance procedures.
6. Unless other additional information is required by the detailed equipment specifications, the following information shall be included for motors:
    a. Motor identification number and nomenclature as specified
    b. Make and motor type
    c. Brake horsepower of the motor
    d. Locked rotor current at full load
    e. Motor efficiency at full load (3-phase motors only)
    f. Starting torque
    g. Method of insulating and impregnating motor coils (3-phase only)
    h. Speed of the motor at full torque
    i. Full load current
    j. Service factor
    k. Motor temperature rise measured by resistance over 40 degrees C ambient

B. **The Contractor shall provide a monthly report to the Owner/Engineer for review stating that the Master Electrician has been to the job site and thoroughly reviewed the work. The report shall be signed by the Master Electrician and include the date and time the Master Electrician was on site.**

C. The Contractor shall submit a copy of the Master Electrician's license and Journeyman's license who will be working on the project. This information shall be submitted as a formal submittal prior to beginning any work.

D. The Contractor shall:

1. Prepare, and keep up-to-date, the Record Drawings and detailed construction drawings which shall be available at each monthly pay application.

2. Record the exact locations of each of these differences, sizes and details of the Construction Work as executed, with cross-references to and other requirements on the Record Drawings.
    a. Record Drawings shall include the location of all pull boxes, junction boxes, concrete pull boxes, manholes and hand holes that were provided under this contract and those existing boxes that were modified under this project (by either the addition or removal of cable/conduits).
        1). The Contractor shall also include on the drawings a label next to each pull box, junction box, concrete pull box, manhole and handhole to reflect the nameplate label installed (existing or new) at each device.
        2). Refer to Section 26 05 53, "Identification for Electrical Systems" for labeling requirements for pull boxes, junction boxes, concrete pull boxes, manholes and hand holes.
3. Keep the Record Drawings on the Work Site;
4. Upon completion of the Work, or at such other time as may be determined by the Engineer, submit the Record Drawings and copies to the Owner's Representative in accordance with the Owner's Requirements.
5. Underground Interference drawing showing all underground duct banks, ground rods, ground conductors, pipes, piers, vaults, manholes, pull boxes, etc. that clearly identifies the location and routing of these systems. All interferences shall be brought to the Engineer's attention. Provide as a minimum the ductbank dimensions, burial depth and coordinates of terminations and those of any changes of direction. The GPS coordinates of the ductbank shall be measured (width, depth, and burial depths) prior to back filling.
6. Provide revised final shop drawings in AutoCAD format noting any changes made to equipment during start-up.
7. Submit master electricians report with each pay application as specified in paragraph 1.02.A. of this specification.

E. The Contractor shall provide a copy of the complete one-line diagram at the site. The one-line diagram shall be as follows:
    1. The one-line shall reflect all changes made including but not limited to changes made during construction.
        a. A wall mounted copy of the complete one-line diagram from the electrical power system studies shall be mounted in the electrical room. The copy shall be framed in a picture frame with plexiglass. The copy of the sheet shall lay flat against the plexiglass without any wrinkles and other material necessary for the copy to lay flat shall be provided within the picture frame.
    2. Each page of the one-line shall be framed in a separate picture frame with plexiglass. The copy of the sheet shall lay flat against the glass without any wrinkles and other material necessary for the copy to lay flat shall be provided within the picture frame.

1.04 STANDARDS

A. Electrical work shall be executed in accordance with local, State and national codes, ordinances and regulations which have jurisdiction or authority over the work. If the standards and codes conflict with each other, the most stringent shall apply. The applicable provisions of the following standard shall apply as if written here in their entirety:

1. National Electrical Manufacturer Association (NEMA)
2. American Society for Testing and Materials (ASTM)
3. National Fire Protection Association (NFPA)
4. National Electrical Safety Code (NESC)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Electrical Code (NEC)
7. Underwriters' Laboratories (UL)
8. American National Standards Institute (ANSI)
9. Uniform Building Code (UBC)
10. Occupational Safety and Health Administration (OSHA)
11. Local utility companies
12. Local Electrical Ordinance
13. Rural Electrification Association (REA)
14. Insulated Power Cable Engineers Association (IPCEA)
15. International Electrical Testing Association (NETA)
16. National Electrical Contractors Association (NECA)
17. Association Edison Illuminating Companies (AEIC)

B. Electrical work shall be performed under the direct supervision of a Master Electrician who holds a valid license in the State of Texas.

1.05 DELIVERY AND STORAGE

A. Follow the Manufacturer's directions for the delivery, storage and handling of equipment and materials. Tightly cover equipment and materials and protect it from dirt, water, chemical or mechanical injury and theft. Major electrical equipment shall be stored indoors in a climate controlled atmosphere and space heaters energized where applicable. Stored equipment shall be properly protected from rodents such as mice and rats.

B. Equipment that will be stored indoors for an extended period of time and that do not have space heaters shall have a 100 watt incandescent light placed in it and energized to eliminate the build-up of condensation in the equipment. Coordinate with equipment manufacturer for additional storage requirements. Damaged equipment shall not be acceptable. Upon installation, protect the materials until the work is completed and accepted by the Owner. Improperly stored equipment is subject to rejection by the Owner/Engineer and will not be allowed to be installed.

1.06 JOB CONDITIONS

A. Permits, licenses, inspections and testing shall be secured and paid for as required by law by the Contractor for the completion of the work. Certificates of approval shall be secured, paid for, and delivered to the Owner before receiving the final acceptance of the work.

B. The location of materials, equipment, devices and appliances indicated are approximate and subject to revisions at the time the work is installed. Final location shall be as proposed by the Contractor and approved by the Engineer.

C. Should project conditions require any rearrangement of work, or if equipment or accessories can be installed to a better advantage than the general arrangement of work on the plans, the Contractor shall before proceeding with the work prepare and submit plans of the proposed rearrangement for the Engineer's review and approval.

D. Motor Horsepower ratings identified are anticipated ratings. If the actual equipment is a different size, the Contractor shall provide the appropriate wiring, conduit, over current protection, starters and accessories for a complete and working system at no cost to the Owner.

E. Enclosures for equipment in the air-conditioned rooms shall be NEMA 1, 14 gauge steel and NEMA 3R, 304 Stainless Steel for all other interior locations unless noted otherwise. All enclosures shall have a quick release luggage type clasp or single handle operated, 3-point latching system.

F. All enclosures for equipment unless specified otherwise shall be NEMA 3R, 304 stainless steel for exterior applications. All enclosures shall have a quick release luggage type clasp.

G. No equipment is to be energized until the Power System Studies have been completed, the protective relays and breakers have been set per the Short Circuit and Relay Coordination Study and the arc flash labels have been installed on the equipment. **NO EXCEPTIONS**.

2.00 EXECUTION

2.01 INSTALLATION

A. Maintain the waterproof integrity of conduit penetrations through the roof, exterior walls and floors. Roof penetrations shall not be located above any electrical equipment.

B. Install stainless steel sleeves for each conduit passing through floors. Extend sleeves 1-1/2" above the floor slab and grout watertight. The sleeve sizes shall permit the subsequent insertion of a properly sized conduit or raceway.

C. Submit location drawings and obtain Engineer approval prior to installing conduit penetrations through slabs, beams, ceiling and walls. The Contractor shall not core drill through existing beams. After the conduits are installed fill the annular space between the conduits with mastic. The complete installation shall be watertight and the fire rating of penetrations through walls, floors and ceilings shall be maintained.

D. Install steel reinforced concrete foundations below floor mounted switchboards, panelboards, motor control centers, soft starters, adjustable frequency drives, transformers, and other floor mounted electrical equipment. Concrete foundations shall be not be less than 4" high or as indicated on plans. Neatly chamfer top edges. Concrete foundations shall be 6" wider and 6" longer than the base of the equipment being installed or as indicated on plans. Concrete shall be in accordance with Division 03, and shall be reinforced with a minimum of 6" x 6" #6 welded wire mesh or as indicated on plans.

E. Route all conduits parallel to building lines, columns, or steel route conduits near to columns and roof beams. Conduits shall maintain a minimum of 3” away from adjacent work (duct work, insulations, etc.)

2.02 CUTTING AND PATCHING

A. Provide adequate support during cutting operations to prevent any damage to the affected masonry. Where openings are cut through masonry walls, provide lintels or structural supports to protect the remaining masonry. The cutting of structural members shall not be permitted without the specific written approval of the Engineer.

2.03 PAINTING

A. Maintain the original factory finish on material and equipment installed, unless specifically indicated on the plans or specifications. If the finish is marred in transit or during installation, re-finish to a neat, workmanlike appearance equal to the original factory finish. Leave equipment and raceway systems clean and free of grease, dirt, rust, and in a suitable condition for painting.

2.04 EXCAVATION, TRENCHING, BACKFILLING AND GRADING

A. Prior to any excavation or trenching, notify the Owner’s representative, utility companies and Owner’s facilities department. Allow sufficient time for utilities to be located prior to excavation to avoid disruption of services. Provide a minimum of 72 hours written notice to the Owner prior to trenching or excavation. Do not proceed with trenching or excavation until authorized by the Owner. Utilities or services which are damaged, which are identified prior to excavation or trenching, or where confirmation by utility companies has not been obtained verifying that utilities are marked, shall be repaired to operable condition immediately, at no cost to the Owner.

B. Barricade open trenches and excavations for the entire duration of the project. Barricades for excavations shall have warning lights maintained during hours of darkness. Trenches shall be marked with warning tape, or access to trenches shall be prohibited with readily identifiable sawhorses, warning tape or other acceptable means. Barriers shall be illuminated or recognizable during hours of darkness. Barriers and tape shall be properly maintained at all times.

C. Protect all adjacent work, structures and properties. Damage to adjacent work, structures or properties shall be repaired, or the cost of repair reimbursed in full.

D. All construction areas shall be finally graded as indicated on the contract documents, or to the conditions of the site prior to construction. Grading shall bring the site back to the existing conditions as close as practical. Turfed areas shall be sodded, or hydro-mulched with matching turf. Landscaping shall be replaced with identical shrubbery, ground cover, or plants as existed. The Contractor shall be responsible for maintaining water on new turf and landscaping until established. If new turf and landscaping is impractical due to weather conditions, Contractor shall provide satisfactory arrangements to have turf and landscaping furnished and installed at the earliest opportunity thereafter. Provide a 90-day warranty on new turf and landscaping.

E. Determine if irrigation systems exist prior to trenching and excavation. Obtain record or as-built drawings and locate control wiring and pressure main branches and devices. Determine by actual operation that systems are functional and repair or replace damaged systems to their original condition prior to beginning construction.

2.05 LOCKING OF ELECTRICAL FACILITIES

A. Install locks immediately upon the installation of the electrical facility. Provide padlocks for exterior electrical facilities subject to unauthorized entry. Furnish the Owner with two (2) keys per lock up to a quantity of 10 keys. Furnish locks to match the Owner's locking system. Locks shall also be provided where required to obtain an electrical Certificate of Occupancy.

2.06 CLEAN AND ADJUST

A. Remove shipping labels, dirt, paint, grease, and stains from equipment. Remove debris as it accumulates. Upon completion of work, clean electrical equipment and the entire electrical installation so that it is suitable for the Owner's use.

END OF SECTION

26 05 19 LOW VOLTAGE ELECTRICAL CONDUCTORS & CABLES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install and test 600 volt wires and cables. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

B. Work shall include building wire, cable, wiring connections and terminations, and modular wiring systems.

1.02 QUALITY ASSURANCE: TESTING

A. Megger test circuits for continuity and ground. Verify phasing at connection points. Torque test conductor connections and terminations to the Manufacturer's recommended values. Megger tests shall be performed by a testing company with a minimum of 10 years’ experience. All low voltage cables shall be verified by use of telephone communications.

1.03 SUBMITTAL PROCEDURES

A. Submittal Procedures shall be in accordance with Section 01 30 00, “Document Management ” and shall include:

1. Shop Drawings:

a. Low voltage wire

b. Ground wire

c. Shielded cable

d. Terminations and Connections

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

ICEA S-19-81/NEMA WC-3	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-61-402/NEMA WC-5	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NFPA 70	National Electrical Code
ANSI/TIA/EIA 606A	Standard for Telecommunications Infrastructure
UL 83	Thermoplastic Insulated Wires and Cables
UL 1063	Machine Tool Wires and Cables
ASTM B3	Soft or Annealed Copper Wires

ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium, Hard, Soft

1.05 DELIVERY AND STORAGE

A. Deliver cable and wire to the project site in the original packages. Conductors with damaged insulation or exposed nylon jacketing shall not be permitted.

B. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable.

C. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel.

D. Do not drop reels from any height.

E. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the wire and cable.

F. Store cable on a solid, well drained location. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

G. Provide moisture protection by using manufacturer's standard procedure or heat shrinkable self-healing end caps applied to both ends of cable. Do not remove end caps until cables are ready to be terminated.

2.00 PRODUCTS

2.01 GENERAL

A. Wires and cables shall be soft-drawn, annealed copper with a conductivity of not less than that of 98% pure copper, UL83 and UL1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90 Celsius in dry locations and in wet locations

B. Conductors #8 or larger shall be stranded and conductors #14 shall be stranded. Utilize single conductors.

C. Except for control, signal and instrumentation circuits and as specifically indicated on the plans the minimum conductor permitted is #12.

2.02 WIRE MARKING

A. Wire marking shall be in accordance with the National Electrical Code Article 310 and shall be printed on the wire insulation at 2 foot intervals. The printing method used shall be permanent and the color shall sharply contrast with the jacket color.

B. Wire marking shall include the U.L. label and necessary identification, including the Manufacturer, the number of conductors, size, conductor insulation type, sun-resistance, and other pertinent information.

2.03 CONDUCTORS AND CABLES

A. SINGLE CONDUCTOR CABLES: Conductor with thermoplastic insulation rated at 600 volts and insulated with type XHHW-2 insulation. Wire shall be water tank tested and approved as machine tool wire, in accordance with National Machine Tool Builders Association. Wire in light fixture channels and other special locations shall be as specifically noted for temperature in NEC Article 300. Conductors #8 or larger and conductors #14 shall be stranded. Wire shall be manufactured by Southwire, Okonite, Encore, General Cable, or Houston Wire & Cable.

B. MULTI-CONDUCTOR CABLES: Type TC; multi-conductor cable specifically approved for the installation of cable trays, in accordance with NEC Article 340. Each cable conductor shall be insulated with XHHW-2 type insulation rated at 600 volts. The individual conductors shall be twisted together and jacketed with a PVC outer covering. Cables shall be 600 volts in accordance with NEC-725 and IEEE 383 and shall be suitable for wet location. Cable shall be as manufactured by Southwire, Okonite Okoseal-N, General Cable or Houston Wire & Cable.

C. GROUND WIRE: Ground wire shall be Class B stranded tin-plated conductor without insulation in all cases where a single ground wire is indicated to be installed in a conduit with no other conductors in the conduit, or where the ground wire is directly buried in earth or concrete. In all other cases, insulate ground wire with green insulator as specified for low voltage wire.

D. PAIRED SHIELDED CABLE: Individually and overall shielded 18 gauge, 7/28 stranded, tinned copper conductors with .021" extruded PVC; .004" nylon insulation twisted into pairs, stranded into a core and enclosed by a non-hygroscopic core tape, 100% coverage, helically wound, aluminum foil shield, drain wire, and .050" minimum extruded PVC jacket. Pairs shall be black/red or black/white numbered. Cables shall be 600 volts in accordance with NEC-725 and IEEE 383 and shall be suitable for wet location and cable tray rated. Cables shall be manufactured by Alpha, Okonite, General Cable, Southwire, Belden, or Houston Wire & Cable.

E. TRIAD SHIELDED CABLE (RTD CABLE): RTD cable shall have the following characteristics:

1. Twelve (12) or as indicated on the plans, with three (3) 18 AWG conductors.
2. Triads shall each have individual shield and overall shield.
3. Each conductor insulated for 600V and entire cable rated for 90 Celsius in dry locations and 75 Celsius in wet locations.
    a. Primary Insulation: 15 mils nominal; PVC; 4 mils nylon
    b. Number of Conductors: 3
    c. Color Code: Black and white and red
    d. Group Identification: Each triad numbered
    e. Pair Shield: 100% coverage; .35 mil aluminum x .5 mil Mylar tape and 20 gauge 7 strand tinned copper drain wire; shield tape to be applied to give a total shield isolation from all other triad shields.
    f. Cable Shield: 100% coverage; 2.35 mil aluminum Mylar tape shield and an 18 gauge 7 strand tinned copper drain wire.

g. Jacket: Black 90 Celsius FR PVC

4. RTD cable shall be as manufactured by Houston Wire & Cable, General Cable, Okonite or Belden.

2.04 WIRE CONNECTIONS AND DEVICES

A. CONNECTORS, COMPRESSION, COPPER, 600 VOLT: As manufactured by Burndy, Thomas & Betts, or Ideal Industries; of the appropriate hole sizes and spacing which are in accordance with NEMA standards; two (2) holes in the tongue for use on conductor sizes 250 kcmil or larger; not required for connections to the circuit breakers in the lighting and/or receptacle panels. All compression connectors shall be long-barrel type, no exceptions.

B. 600 VOLT PLASTIC TAPE: Minnesota Mining & Manufacturing Company (3M), No. 35.

C. WIRENUTS: Silicone-based pre-filled spring wire connecting devices with plastic covering; UL listed for damp and wet locations. Wirenut shall meet requirements of UL 486D for Sealed Wire Connector Systems and shall be manufactured by Ideal Industries, Inc model 63, or as manufactured by ITT or Panduit. Wirenut shall be spring insulated, properly sized and resistant to vibration may be used for No.12 through No.10 solid gauge conductor for lighting and branch circuits only.

D. SPLIT BOLTS: Kearney, Burndy, or Ilsco; shall be usable for connecting conductors which are both copper, both aluminum or one copper and one aluminum. Split bolts shall have a spacer between the two conductors, which it connects.

E. MECHANICAL SET SCREW CONNECTOR: Blackburn HPS, ADR-ALCUL, GP or GT, Burndy or Ilsco; consisting of an aluminum body which has openings on opposite ends for insertion of the conductors. Conductors inserted into these holes shall each be clamped by two set screws. Connectors shall be suitable for use with copper conductors.

F. RUBBER TAPE: Scotch 2210.

G. VINYL TAPE: Scotch 88.

H. ARC PROOFING TAPE: 3M “Scotch 77 Fire and Electric Arc Proofing Tape”. Fireproofing shall be done with a half-lapped layer of arc proofing tape, anchored at each end with a double wrap of 3M “Scotch 69 Glass Cloth Electrical Tape”.

I. INSULATING RESIN: Scotch 3576, 3577, or 3578.

J. POWER DISTRIBUTION BLOCKS: Mersen, or Ilsco; rated for 600 VAC and termination of copper conductors. Individual poles shall be constructed of tin plated aluminum and mounted on an insulating base.

3.00 EXECUTION

3.01 PREPARATION

A. Completely swab raceway system before installing conductors. Do not use cleaning agents and lubricants which have a deleterious effect on the conductors or their insulation.

3.02 INSTALLATION

A. GENERAL

1. Install raceway first as a complete system without conductors. Do not install pull wires and conductors until the raceway system is in place in accordance with the NEC and these specifications. Exception: Only flexible connections to motors shall be permitted to be installed after the installation of the remainder of the raceway system. The installation of these conductors shall be limited to exposure to damage for a maximum of one (1) week prior to installing flexible connection and making final terminations. Any conductors exposed to damage (i.e. not installed in raceway) longer than one (1) week shall be subject to rejection by the Owner and/or Engineer. If rejected, the cables shall be removed, discarded, replaced, reinstalled and retermination at the Contractor's expense.
2. Installed unapproved wire shall be removed and replaced at the Contractor's expense.
3. Grouping conductors together into one conduit shall not be allowed where the plans indicate the conductors to be placed in separate conduits. Each home run shown on the plans shall be in its own conduit.
4. Neatly train wiring inside boxes, equipment and panelboards. Pull conductors into a raceway at the same time and use U.L. listed, wire pulling lubricant for pulling No. 4 AWG and larger wire.
5. Except for hand-pulled conductors into raceways, all wire and cable installation shall be installed with tension-monitoring equipment. Where conductors are found to have been installed without tension-monitoring, the conductors and cables shall be immediately removed from the raceways, permanently identified as rejected material, and removed from the jobsite. New conductors and cables shall be reinstalled, tagged and raceways resealed, all at the Contractor's expense.
6. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved.
7. All wire and cable installed in cable trays shall be UL Listed as Type TC, for cable tray use.
8. Where single conductors and cables in manholes, hand holes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 4 inches on center.
9. Properly support cables in accordance with the NEC and manufacturer's recommendations in all raceways. Provide strain relief as required.
10. Arrange wiring in cabinets and panels neatly cut to proper length, remove surplus wire, and bundle and secure in an acceptable manner. Identify all circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein and in specification Section 26 05 53, "Identification For Electrical Systems."
11. Cap spare conductors and conductors not terminated, with the UL listed end caps.

12. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.
13. For conductors that will be connected by others, provide at least 6 feet spare conductors in free standing panels and at least 2 feet spare in other assemblies. Provide additional spare conductor in any particular assembly where it is obvious that more conductor will be needed to reach the termination point.
14. Each circuit shall include a ground wire. Sharing grounds or neutrals is not allowed.

B. SPLICES

1. Power Conductors: Splice in junction boxes or at outlets only for lighting and receptacle branch circuits. Splices for all other circuits shall be disallowed. All splices are subject to the Engineer's approval. Obtain approval from Engineer before installing any splices.
    a. For existing installations, splices of 120V circuits shall use twist-on wire nuts.
    b. For splices of existing 480V circuits, the Contractor shall terminate the existing and new conductors using power distribution blocks mounted in a junction box.
2. Control and Instrumentation Conductors: No splicing of control and instrumentation conductors shall be permitted between terminal points except as specifically indicated on the plans.
3. No splicing of conductors shall be performed in any below ground structure.
4. Condulet type fittings shall not contain splices. Under no condition shall conductors of a different color be spliced together.
5. For No. 10 and smaller, connect conductors with a twist-on spring wirenut. If a splice or tap is below 3' above the final grade, fill the spring connectors with an electrical insulating resin so that the resin encapsulates conductor and spring materials. Conductor splices and taps inside the MCC, VFDs, panels, etc. shall be on the terminal strips or power distribution blocks.
6. For No. 8 and larger, connect conductors with a split bolt type of connector or a mechanical, set screw type connector. Wrap splices and taps with a single half-lapped layer or rubber tape followed by successive layers of vinyl tape until a vinyl tape layer thickness of twice the original conductor insulation thickness is achieved. If splice or tap is below 3' above the finished grade, the tape or splice shall have a final outer coating or insulating resin.

C. TERMINATIONS

1. Conductors terminated on a screw termination shall have a crimp on type spade connector applied on the wire end, Panduit PanTerm or approved equal.
2. Furnish and install power distribution blocks as required for tapping conductors at their load connection point with conductors of smaller size. Install power distribution blocks with the number of poles and sizes needed for connecting the phase, neutral, and ground conductors.
3. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

4. Use crimp connectors on all stranded conductors.
5. Soldered mechanical joints insulated with tape will not be acceptable.
6. SINGLE CONDUCTORS: Sufficient wire shall be left at outlets to make connections to equipment without straining. Light switches and receptacles shall be connected with pig-tails and crimp-on connectors.
7. PAIRED SHIELDED AND TRIAD SHIELDED CABLE: Ground paired shielded and triad shielded cables at the instrument panel or starter end only and insulate from ground elsewhere. The shield shall be continuous for the entire run. The paired shielded and triad shielded cable shall not be laced with or placed in the same conduit with power cables and digital control cables. Each termination of paired shielded or triad shielded cable shall be coated with silicone jelly after termination. The shield of pair shielded cable and triad shielded cable shall only be broken when the conductors are terminated on terminal strips. Each conductor and shield shall be landed on its own terminal. Sharing of shield shall not be allowed.

D. GROUNDING

1. Conduits and other raceway shall contain an equipment grounding conductor whether the raceway is metallic or not. Conduits, motors, cabinets, outlets, and other equipment shall be properly grounded in accordance with National Electrical Code requirements. Where ground wire is exposed to mechanical damage, install wire in rigid aluminum conduit. Make connections to equipment with solderless connections. All connections to ground rods shall be of the fused type utilizing an exothermic welding process.
2. Ground metallic material, including but not limited to metallic raceway, metallic boxes and metallic enclosures. Where metallic material is not connected by raceway to a solid ground, connect the metallic material to the largest equipment grounding conductor, which it houses. Clean the metal surface under the grounding lug to bright metal. Grounding connections to motors shall be to the grounding stud, which shall be threaded into the stationary frame; Use Burndy KC Servit, or approved equal. The ground wire shall not be lugged to a mounting bolt.
3. Ground wire shall be uninsulated tin plated copper sized as shown on the plans in all cases where a single ground wire is indicated to be installed in a conduit with no other conductors in the conduit, or where the ground wire is directly buried in earth or concrete. In all other cases, insulate ground wire with green insulation as specified for low voltage wire. Provide and size bonding conductors in accordance with the National Electrical Code.
4. Provide a bare uninsulated ground wire to run the entire length of all cable trays. The contractor shall bond to each section and to every enclosure served by conductors routed through the cable tray system

E. TESTING

1. Testing: All testing required shall be per Specification Section 26 01 26, “Testing of Electrical Systems”.

2. Perform tests and inspections and prepare test reports and submit to the Owner/Engineer prior to final inspection. Test reports shall be submitted as required by Specification Section 26 01 26, “Testing of Electrical Systems”. All test reports shall be submitted in one binder under Specification Section 26 01 26, “Testing of Electrical Systems”.
3. Tests and Inspections:
    a. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
    b. Perform each visual and mechanical inspection and electrical tests stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    c. Test Reports: Prepare a written report to record the following:
        1). Test procedures used
        2). Test results that comply with requirements.
        3). Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
    d. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

26 05 23 CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install 600-volt wires and cables. Electrical Work shall be in accordance with Section 26 05 00 “Common Work Results for Electrical.”

B. Work shall include building wire, cable, wiring connections and terminations, and modular wiring systems.

1.02 SUMMARY

A. Section Includes:

1. UTP cabling.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Triad shielded cable (RTD cable).
6. Identification products.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low-Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 volts or for remote-control and signaling power-limited circuits.

C. RCDD: Registered Communications Distribution Designer.

D. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 02 “Shop Drawings” and shall include:

1. Shop Drawings: For each type of product.
2. Source quality-control reports.
3. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

2.00 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. ADC.
3. Alpha Wire Company.
4. AMP NETCONNECT; a Tyco Electronics brand; a TE Connectivity Ltd. company.
5. Belden CDT Networking Division/NORDX.
6. Berk-Tek; a Nexans company.
7. CommScope, Inc.
8. Draka USA.
9. General Cable; General Cable Corporation.
10. Genesis Cable Products; Honeywell International, Inc.
11. KRONE Incorporated.
12. Mohawk; a division of Belden Networking, Inc.
13. Nexans.
14. Siemon.
15. Siemon Co. (The).
16. Superior Essex Inc.
17. SYSTIMAX Solutions; a CommScope Inc. brand.

B. Description: 100-ohm, four-pair UTP , 24-pair UTP, formed into four-pair binder groups with no overall jacket.

1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.
3. Comply with TIA-568-C.1 for performance specifications.
4. Comply with TIA-568-C.2, Category 5e.
    a. Communications, General Purpose: Type CM or Type CMG ; or Type CM, Type CMG, Type CMP, or Type CMR in listed communications raceways.

b. Communications, Limited Purpose: Type CMX ; or Type CM, Type CMG, Type CMP, or Type CMR.

2.03 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. AMP NETCONNECT; a Tyco Electronics brand; a TE Connectivity Ltd. company.
4. Belden CDT Networking Division/NORDX.
5. Belden Inc.
6. Corning Cable Systems.
7. Dynacom Corporation.
8. Hubbell Incorporated; Wiring Device-Kellems.
9. Hubbell Premise Wiring.
10. KRONE Incorporated.
11. Leviton Manufacturing Co., Inc.
12. Molex Premise Networks.
13. Panduit Corp.
14. Siemon Co. (The).

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

1. Number of Terminals per Field: One for each conductor in assigned cables.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

E. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have color-coded boots for circuit identification.

F. Workstation Outlets: Two-port-connector assemblies mounted in single or multigang faceplate.

G. Faceplates:

1. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 “Wiring Devices.”

2. For use with snap-in jacks accommodating UTP work area cords.
    a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

H. Legend:
1. Factory labeled by silk-screening or engraving for stainless faceplates.

2.04 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.
1. Paired, No. 24 AWG, stranded 7x28 tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.

2.05 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.
1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

2.06 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.
1. Individually and overall shielded one pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors with 0.021-inch extruded PVC; 0.004-inch nylon insulation twisted into pairs, stranded into a core and enclosed by a non-hygroscopic core tape, 100 percent coverage, helically wound, aluminum foil shield, and drain wire. Pairs shall be black/red or black/white numbered. Cables shall be 600 volts in accordance with NEC-725 and IEEE 383 and shall be suitable for wet location.
2. Unshielded.
3. Extruded PVC jacket minimum 0.050.
4. Flame Resistance: Comply with UL 1685.

2.07 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable; General Cable Corporation.
2. Southwire Company.
3. Alpha.
4. Okonite.
5. Belden.
6. Houston Wire and Cable.

B. General:

1. Wires and cables shall be soft-drawn, annealed copper with a conductivity of not less than that of 98 percent pure copper, UL 83 and UL 1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90 degrees Celsius in dry locations and in wet locations.
2. Control, signal and instrumentation circuits and as specifically indicated on the Drawings the minimum conductor permitted is #14.

C. Single Conductor Cables: Conductor with thermoset insulation rated at 600 volts and insulated with type XHHW-2 insulation. Wire shall be water tank tested and approved as machine tool wire, in accordance with National Machine Tool Builders Association.

D. Class 1 Control Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.

E. Class 2 Control Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.

F. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.

2.08 TRIAD SHIELDED CABLE (RTD CABLE)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable; General Cable Corporation.
2. Okonite.
3. Belden.
4. Houston Wire and Cable.

B. Eight or as indicated on the Drawings, with three 18 AWG conductors.

1. Triads shall each have individual shield and overall shield.
2. Each conductor insulated for 600 volts and entire cable rated for 90 degrees Celsius in dry locations and 75 degrees Celsius in wet locations.
    a. Primary Insulation: 15 mils nominal; PVC; 4 mils nylon.

b. Number of Conductors: 3.

c. Color Code: Black and white and red.

d. Group Identification: Each triad numbered.

e. Pair Shield: 100 percent coverage; 0.35-mil aluminum x 0.5-mil Mylar tape and 20 gauge 7 strand tinned copper drain wire; shield tape to be applied to give a total shield isolation from all other triad shields.

f. Cable Shield: 100 percent coverage; 2.35-mil aluminum Mylar tape shield and an 18 gauge 7 strand tinned copper drain wire.

g. Jacket: Black 90 Celsius FR PVC.

2.09 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.00 EXECUTION

3.01 EXAMINATION

A. Test cables on receipt at the Site.

1. Test each pair of UTP cable for open and short circuits.

3.02 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems” for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Comply with BICSI ITSIMM, Ch. 5, “Copper Structured Cabling Systems”.

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, and terminals,.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems".
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems". Monitor cable pull tensions.
9. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:
1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors: Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating Between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating Between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment or Circuit Rating Between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

3.04 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
    1. Class 1 remote-control and signal circuits; No. 14 AWG.
    2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
    3. Class 3 low-energy, remote-control, alarm, and signal circuits; No. 12 AWG.

3.05 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, “Bonding and Grounding (Earthing)” Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 “Grounding &Bonding for Electrical Systems.”

3.06 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems.”

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:
    1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
    2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.08 PREPARATION

A. Completely swab raceway system before installing conductors. Do not use cleaning agents and lubricants which have a deleterious effect on the conductors or their insulation.

3.09 INSTALLATION

A. General:

1. Conductors shall be continuous from terminal block to terminal block without splice. Condulet type fittings shall not contain splices. No splicing of conductors shall be performed in any below ground structure.

2. If rejected, the cables shall be removed, discarded, replaced, reinstalled and re-terminated at the Contractor's expense.

3. Grouping conductors together into one conduit shall not be allowed where the Drawings indicate the conductors to be placed in separate conduits. Each home run shown on the Drawings shall be in its own conduit.

4. Properly support cables in accordance with the NEC and manufacturer's recommendations in all raceways. Provide strain relief as required.

5. The cable shall not be bent to a radius no smaller than the manufacturer cable's minimum bending radius.

6. All terminated conductors shall be labeled as specified prior to testing and final terminations being done. Any conductor that is de-terminated for any reason shall be re-tested. All associated controls, if tested before, shall be re-tested following final re-termination.

B. Paired Shielded and Triad Shielded Cable: Ground paired shielded and triad shielded cables at the instrument panel or starter end only and insulate from ground elsewhere. The shield shall be continuous for the entire run. The paired shielded and triad shielded cable shall not be laced with or placed in the same conduit with power cables and control cables. Each termination of paired shielded or triad shielded cable shall be coated with silicone jelly after

termination. The shield of pair shielded cable and triad shielded cable shall only be broken when the conductors are terminated on terminal strips. Each conductor and shield shall be landed on its own terminal. Double terminations of any conductor or shield shall not be allowed.

C. Ground Conductors: Conduits and other raceway shall contain an insulated equipment grounding conductor whether the raceway is metallic or not. Conduits, cabinets, and other equipment shall be properly grounded in accordance with National Electrical Code requirements. Where ground wire is exposed to mechanical damage, install wire in rigid aluminum conduit. Bond each end of each of the conduit to the ground system. Make connections to equipment with solderless connections.

END OF SECTION

26 05 26 GROUNDING & BONDING FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC) as shown on the drawings or as specified herein. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

1.02 SUBMITTALS

A. Submittal shall be in accordance with Section 01 33 00, “Document Management ” and shall include:

1. Grounding materials, equipment and processes.
2. Product Data: For each type of product supplied.
3. Field quality-control grounding test reports.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

1.04 JOB CONDITIONS

A. Measure the ground grid resistance with the earth test megger and install additional ground rods and conductors as required until the resistance to the ground conforms to National Electrical Code requirements. Ground resistance measurement shall not exceed 5 ohms. Add ground rods as required to bring resistance to 5 ohms and connect to grounding system.

2.00 PRODUCTS

2.01 MATERIALS

A. GROUND RODS: 316 copper clad, having a diameter of 3/4" and a minimum length of 10'.

B. GROUND CABLES: Stranded, bare copper of 98% conductivity and as specified in Section 26 05 19, “Low Voltage Electrical Conductors & Cables”.

C. CONDUIT GROUND FITTINGS: Fittings for bonding ground cable to the conduit shall be FCI Burndy Corp., type NE or Thomas & Betts No. 3951 series.

D. GROUND ROD BOXES: Precast Box with cast iron lid. Lid shall read “ground rod” on lid. Brooks Precast Model. “3-RT” or approved equal. Ground rod boxes located in driveway areas shall have an AASHTO HS-20 rating.

E. EXOTHERMIC WELDING PROCESS: CADWELD MATERIALS – as manufactured by ERICO products or approved equal.

F. GROUND PAD: Flat plate all copper alloy ERICO CADWELD B164-2Q or equal. Ground pad shall be installed in concrete foundations or pad for connections to motors and transformers. Ground pad shall be exothermic weld connection for connection to ground cable.

2.02 PROCESSES

A. All grounding system connections to building steel and ground rods shall be exothermically welded including all cable connections, and cable steel terminations. The use of mechanical type connections is not acceptable.

B. Any concealed connection (buried, encased in concrete or otherwise sealed) shall be done only with exothermic welds.

C. All materials involved must be from the same sources to insure compatibility. Connections made from this process shall meet the requirements of IEEE Standards 80 and 837 and as listed in MIL 419 and other standards, National Electrical Code, etc.

2.03 GROUNDING SYSTEM

A. Provide a complete grounding system that includes all connections and the testing of ground rods, ground cables, ground buses, conduits, fittings, anchor supports, thermite process materials and equipment and other materials required for a complete installation. Grounding system shall be installed and sized in accordance with the National Electrical Code.

3.00 EXECUTION

3.01 INSTALLATION

A. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted/clamp type connectors.
2. Underground Connections or any concealed location: Exothermically welded connectors,
3. Connections to Ground Rods at Test Wells: Exothermically welded connectors.
4. Connections to Structural Steel: Exothermically welded connectors.
5. Connections to equipment: NEMA ground pads and insulated jumpers.
6. Connection to Ground Pad: Exothermic.
7. The use of “pig tails” for connections to ground loops or equipment shall not be allowed.

B. Ground electrical work in accordance with NEC Article 250 and local codes.

C. Install ground cables in conduits above grade or directly buried in earth to a depth of not less than 18” to 24" below grade. Installation to provide sufficient mechanical protection so as not to break ground cables or connections. If ground cables are exposed, run in conduits for added protection.

D. Install ground cables continuously between connections. Splices shall not be permitted, except where indicated on the plans. Where ground cables pass through floor slabs, buildings, etc., and when not in metallic enclosures, provide a sleeve of approved, non-metallic materials.

E. Install a green-colored, equipment grounding conductor in raceways. Size conductors in accordance with NEC Article 250.

F. Where ground wire is directly buried in earth or concealed in concrete, structures or duct banks use standard bare copper cable, in all other cases install a green-colored insulation, equipment grounding conductor in accordance with Section 26 05 19, “Low Voltage Electrical Conductors & Cables”. Size conductors in accordance with NEC Article 250. Provide grounding conductors as required per the NEC. For larger conductors where green insulation is not available, provide green indicating tape per the National Electrical Code.

G. Metal conduits stubbed up into switchgear, motor control center or other electrical equipment shall be terminated with insulated grounding bushings and connected to the equipment ground bus. Size the grounding wire in accordance with applicable sections of the National Electrical Code. Provide grounding and bonding jumpers as required per the NEC and sized in accordance with the NEC.

H. Provide exothermic weld connection for extension to existing stub-up ground conductors.

I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

   1. Provide grounding and bonding jumpers as required per the NEC.

   2. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

   3. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment. Bolt-on or crimp-on connections in lieu of exothermic welds, shall only be used upon Owner/Engineer’s approval in writing on a case by case basis.

   4. Use exothermic-welded connectors for outdoor locations, but if a disconnect type connection is required; use a bolt on crimp type lug.

J. Grounding and Bonding for Piping:

   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

K. Liquid tight flexible metal conduit in sizes 1-1/2" or larger shall have exceptional bonding jumpers. Bonding jumpers shall be external, run in parallel (not spiraled) and fastened with plastic tie wraps. Bonding jumpers shall be insulated copper conductors. Contractor shall provide bonding jumpers sized in accordance with the National Electrical Code.

L. All equipment enclosures, motor and transformer frames, conduit systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC. Provide grounding and bonding jumpers as required per the NEC and sized in accordance with the NEC.

M. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250.

N. Where exothermic bonding is used, molds shall be of the appropriate size for the wire and rod used. All bonds shall remain exposed for inspection of the Owner's Representative.

O. Run #4/0 bare copper grounded conductor in all cable trays, whether new or existing. Bond ground to each section of the cable tray, to each enclosure, and enclosure ground bus, where cable terminates, to each pump frame and motor frame, and to the building counterpoise. Install cable on the outside rail of tray to avoid damage to conductors from sharp edges on grounding clamps.

P. Ground rod shall be installed such that the top of the ground rod is 6" below grade and enclosed by a ground rod box.

Q. At each convenience outlet, install a grounding clip attached to the outlet box and leave a sufficient length of #12 wire with green-colored insulation to connect to the grounding terminal at the receptacle.

R. Install #4/0 AWG bare copper ground cable that follows the route of the underground duct banks on top of the duct bank envelop, but in no case is embedded in the concrete. Run ground through the manholes and bond to ground rods in manholes.

1. Connect the ground cables of the duct bank to the nearest buried ground loop at both ends. If a ground loop is not available for connection at an end of a duct bank, the Contractor shall drive a 3/4" x 10' ground rod at the end of the duct bank and terminate the ground cable run along the top of the duct bank to the ground rod.
2. Ground all metallic cable racks, supports, and ladders by #4/0 bare copper ground loop exposed on the inside walls of the manhole. Connect the copper loop to the grounding cable that is run above the duct bank and through the manhole.

S. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

T. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each vault, manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Ground all metallic cable racks, supports, and ladders by #4/0 bare copper ground loop exposed on the inside walls of the manhole. Connect the copper loop to the grounding cable that is run above the duct bank and through the manhole.

U. Provide a ground pad in all concrete foundations for connection to equipment and to grounding system. The ground pad shall be ERICO CADWELD B164-2Q or equal. No pigtails allowed.

1. Transformer Pads: Provide a ground pad in the concrete pad. Provide a #4/0 bare copper to the grounding system. Provide two hole spade terminals connected to a #4/0 bare copper conductor at each end and connect to the transformer enclosure and to the ground pad.

2. Generator Pads: Provide a ground pad in the concrete pad. Provide a #4/0 bare copper to the grounding system. Provide two hole spade terminals connected to a #4/0 bare copper conductor at each end and connect to the transformer enclosure and to the ground pad.

3. Motor Grounding: Provide a ground pad in the concrete slab. Provide a #4/0 bare copper to the grounding system. Provide two hole spade terminals connected to a #4/0 bare copper conductor at each end and connect to the motor enclosure and to the ground pad and to the pump frame.

4. The use of “pig tails” for connections to ground loops or equipment shall not be allowed.

V. Provide a minimum of two ground connections to all medium voltage equipment including AFD’s and transformer frames.

3.02 INSPECTION

A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

B. Use Biddle Direct Reading Earth Resistance Tester or equivalent to measure resistance to ground of the system. Perform testing in accordance with the test instrument manufacturer’s recommendation using the fall of potential method.

C. All test equipment provided under this section shall be approved by the Engineer.

D. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

E. Testing shall be performed before energizing the distribution system.

F. A separate test shall be conducted for each building or system.

G. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms. Provide additional ground rods and conductors as required to bring the resistance to five ohms.

H. Submit reports of all tests to the Owner/Engineer.

END OF SECTION

26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

1.02 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management ” and shall include Record Data.

B. Provide calculations for load limits for all trapeze-type supports, support assemblies and field fabricated support systems.

1.04 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

2.00 PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Channel Dimensions: Selected for applicable load criteria.

3. Slotted channel shall be 304L stainless steel.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: 304L stainless steel hangers, clamps, straps and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; 304L stainless steel.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, 304L stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1). Cooper B-Line, Inc.; a division of Cooper Industries.

2). Empire Tool and Manufacturing Co., Inc.

3). Hilti Inc.

4). ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5). MKT Fastening, LLC.

2. Concrete Inserts: Stainless Steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: 304L Stainless Steel, Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: 304L Stainless steel springhead type.

6. Hanger Rods: Threaded 304L stainless steel.

7. Washers: 304L Stainless steel.

3.00 EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for rigid metal conduit as required by NFPA 70. Minimum rod size shall be 3/8 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with stainless steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, rigid metal conduit may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

D. All floor mounted equipment shall have a 4” thick housekeeping pad on top of concrete foundations or floor for interior equipment.

END OF SECTION

26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install raceways and boxes, as specified and indicated on the plans.

B. The Contractor shall be responsible for sizing all pull boxes and junction boxes per the NEC Article 314 and all other relevant sections of the NEC. Electrical work shall be in accordance with Section 26 05 00 “Common Work Results for Electrical”.

1.02 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. LFMC: Liquidtight flexible metallic conduit.

C. LFNC: Liquidtight flexible nonmetallic conduit.

D. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

A. Product Data: For raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

2.00 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.

4. Electri-Flex Company.
5. FSR Inc.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Picoma Industries, Inc.
8. Republic Conduit.
9. Robroy Industries.
10. Calbond.
11. Southwire Company.
12. Thomas & Betts Corporation, A Member of the ABB Group.
13. Western Tube and Conduit Corporation.
14. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ARC: Heavy wall, aluminum alloy 6063; low temper number, tube, free from defects and manufactured in accordance with ANSI C80.5 and UL 6A.

D. PVC-Coated Aluminum Conduit: PVC-coated.
   1. Comply with UL 6A.
   2. Exterior Coating Thickness: 0.040 inch, minimum PVC.
   3. Interior Coating Thickness: 0.020 inch, minimum urethane.

E. LFMC: Flexible aluminum conduit with PVC jacket. Single strip, helically wound, interlocking, aluminum, in accordance with UL 360.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for Rigid Aluminum:
      a. Material: Aluminum.
         1). Type: Form 7.
      b. Class I and II Hazardous locations:
         1). Material: Copper-free aluminum.
         2). Type: Series OE, LBH and LBY
         3). Covers: Copper-free aluminum
   3. Fittings for PVC Coated Rigid Aluminum:
      a. Material: PVC Coated Cast Aluminum

b. Type: Form 7.

c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Expansion Fittings: PVC, or aluminum to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper, Crouse Hinds XJG 4" or equal with bonding jumper for aluminum. Where expansion/deflection fitting is specified on the drawings, provide Crouse Hinds XJGD or equal.

H. Insulated Grounding Bushings: Threaded bushings, O-Z Type ABLG with lay-in means of grounding conduit.

I. Fittings for LFMC

1. Fittings for aluminum LFMC shall be aluminum with reinforced sealing gaskets with Thomas and Betts stainless steel retaining ring, external grounding lugs, and insulated throat. Fittings shall be Emerson STB-L or equal.

J. Joint Compound for ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

1. Aluminum conduit: Penetrox A-13 or approved equal.

a. UL Listed

b. Compatible with insulating materials such as rubber, or polyethylene.

c. Rated for all voltages

K. Conduit Seals: Explosion-proof, rigid metal conduit fitting as defined by NEC Article 500, and as manufactured by Crouse Hinds fitting with Chico "X" Fiber and Chico "A" compound or Appleton fitting with Apelco fiber and compound. Seal shall be same material as conduit.

L. Lubricants:

1. Hazardous locations Class I, Div. II locations

a. Metal-to-metal joint: STL thread lubricant.

1). Applicable to dissimilar metals

2). Maintain grounding continuity

b. Lighting Fixture Threaded joint: HTL high temperature lubricant

1). Applicable to dissimilar metals

2). Maintain grounding continuity

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.

2. Anamet Electrical, Inc.

3. Arnco Corporation.
4. CANTEX INC.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions.
10. Niedax Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation, A Member of the ABB Group.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: Comply with UL 514B.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 4X 316 stainless steel unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Flanged-and-gasketed type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

F. Wireways shall come with a threaded grounding post welded to the enclosure used for grounding.

2.04 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Adalet.
2. Crouse-Hinds, an Eaton business.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a brand of Pentair Equipment Protection.
7. Hubbell Incorporated.
8. Kraloy.
9. Milbank Manufacturing Co.
10. MonoSystems, Inc.
11. Oldcastle Enclosure Solutions.
12. O-Z/Gedney; a brand of Emerson Industrial Automation.
13. RACO; Hubbell.
14. Robroy Industries.
15. Spring City Electrical Manufacturing Company.
16. Stahlin Non-Metallic Enclosures.
17. Thomas & Betts Corporation, A Member of the ABB Group.
18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

1. Outlet boxes for Rigid Aluminum:
    a. Material: Aluminum.
        1). Type: Form 7.
    b. Class I and II Hazardous locations:
        1). Material: Copper-free aluminum.
        2). Type: Series GUA
        3). Covers: Copper-free aluminum

D. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: 316 stainless steel.
2. Interior Backplane Panels: Steel; all sides finished with manufacturer's standard enamel.
3. Enclosures shall include a grounding kit.

E. Cabinets:

1. NEMA 250, Type 4X 316 stainless steel galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Cabinet shall include a grounding kit.

2.05 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Concrete Pullboxes

1. ACCEPTABLE MANUFACTURERS; PRECAST: Precast concrete products shall comply with the specifications and shall be produced by the following Manufacturers:
    a. Brooks Products
    b. American Industrial Precast Products
    c. Dalworth Quickset Co.
    d. Old Castle
    e. No Equal
2. ACCEPTABLE MANUFACTURERS; CASTINGS: Metal castings shall comply with the specifications and shall be produced by the following Manufacturers:
    a. McKinley Iron Works, Fort Worth, TX
    b. Neenah Foundry, Neenah, WI
    c. No equal.

3. DESIGN CRITERIA: Concrete for precast concrete shall obtain a compressive strength of 4000 psi minimum at 28 days, and shall be an air-entrained mix of the Manufacturer's standard mix design.
4. STANDARDS
    a. The applicable provisions of the following standards shall apply as if written here in their entirety:

AASHO H-20	"Standard Specifications for Highway Bridges"
ANSI/ASTM A-15	"Zinc Coating (Hot Dipped) on Iron and Steel Hardware"
ANSI/ASTM A-569	"Steel, Sheet and Strip, Carbon (0.15% Maximum), Hot Rolled, Commercial Quality.
ASTM A-48	"Gray Iron Castings"
ASTM A-123	"Zinc (Hot Galvanized) Coatings on Products fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips."

5. Materials
    a. PULLING IRONS: 316 Stainless Steel bar with 7/8" diameter forming a triangle of 9" per side when set; galvanized according to ANSI/ASTM A-153 for irregularly shaped articles.
    b. CABLE RACK INSERTS: 316 Stainless Steel channel inserts with a minimum load rating of 800 pounds; length to match cable rack channel.
    c. CABLE RACK CHANNEL: 4" x 1-1/2" x 3/16" 316 stainless steel channel wall bracket, 48" long, with cable rack arm mounting slots on 8" centers.
    d. CABLE RACKS: 2-1/2" x 14" 316 stainless steel channel with high glazed, wet-process porcelain insulators conforming to ANSI/ASTM A-569.
    e. GROUND ROD: 3/4" x 10’ copper clad steel, installed in the floor of the manhole, and all metallic cable racks, irons, etc. grounded (to the ground rod). Ground rod may be field installed, but floor penetration shall be sealed against the entrance of water under positive head.
    f. JOINT SEALANT: Flexible plastic gasket of flexible butyl resin sealant.
    g. DAMPPROOFING: Sonneborn, Div. of ChemRex, Inc. or approved equal.
        1). BITUMINOUS DAMPPROOFING
            a). Cold-Applied, Emulsified-Asphalt Dampproofing:
            b). Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
        2). MISCELLANEOUS MATERIALS
            a). Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

6. Mixes

    a. Concrete and reinforcing shall be in accordance with Section 03 30 00, “Cast-In-Place Concrete”.

2.06 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

3.00 EXECUTION

3.01 CONDUIT INSTALLATION SCHEDULE

A. Conduit types shall be installed in accordance with the following schedule:

1. BURIED OR CONCRETE ENCASED CONDUIT: Schedule 40 PVC, Type EPC-40-PVC, concrete encased unless noted otherwise. Conduit below grade shall not be smaller than 2”.

    a. Elbows 1.5” and larger: PVC COATED ARC.

    b. Elbows below 1.5” where allowed: PVC COATED ARC

2. ABOVE GRADE NON CONCEALED CONDUIT: ARC unless noted otherwise.

3. PVC COATED RIGID ALUMINUM CONDUIT: Shall be used for conduit stub-ups through concrete and concrete wall penetrations.

4. RIGID ALUMINUM CONDUIT: May be used in all locations. PVC coated rigid aluminum conduit shall be used in corrosive environments or where in contact with concrete.

5. LIQUID TIGHT FLEXIBLE METALLIC CONDUIT: Shall only be used to equipment in non-hazardous locations not subject to physical damage or excessive temperatures, requiring vibration isolation unless otherwise indicated, 6’-0” maximum length. The bending radius shall be in accordance with Chapter 9, Table 2 of the NEC and shall not deform or alter the flex jacket.

6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

7. Boxes and Enclosures, Aboveground: NEMA 250, NEMA 4X 316 stainless steel**.**

8. Boxes and Enclosures, Aboveground for Class I, Div. 2 hazardous locations: NEMA 250 cast aluminum Type 7.

B. Minimum Raceway Size:

1. Underground: 2” in duct banks. 1” independent conduits for power to light poles.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Aluminum Conduit: Use threaded rigid aluminum conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Aluminum Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

D. Where raceways are installed for such circuits and pass through concrete, install PVC Coated Rigid Aluminum extending 6” past the top of the concrete slab where conduit does not terminate in a floor mounted enclosure.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 CONDUIT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations.

B. Use the conduit route where shown on the plans. Route conduits that do not have a specified route in the most direct path between the two points, i.e. home runs shown with an arrow symbol. Route conduits parallel to wet well lines. Concealed conduits on the plans shall be below grade.

C. Install conduit at elevations which maintain headroom, and at locations which avoid interference with other work requiring grading of pipe, the structure, etc. Avoid crossing other work. Conduits shall not be placed in close proximity to equipment, systems, and service lines. Maintain a minimum of 3" separation, except in crossing which shall be a minimum of 1".

D. Group conduit in parallel runs where practical. Use a conduit rack constructed of channels with conduit straps or clamps. Provide space for an additional 25% conduit.

E. Parallel runs of conduit shall have bends and offsets made at the same point such that the angle of bend is the same in each conduit and the conduits remain parallel throughout the run. Conduits not installed in this manner shall be removed and reinstalled at the Contractor’s expense. Conductors that are installed shall be removed and replaced at the Contractor’s expense.

F. Conduits installed in parallel shall be arranged such that crossings are eliminated.

G. Nuts, bolts, concrete anchor bolts and other metallic fasteners shall be 316 stainless steel.

H. Install conduit with threaded couplings and other threaded fittings. Threadless, or clamp type fittings shall not be used on metallic conduit. Rigid aluminum conduit shall have each set of threads coated with an oxidation inhibitor, Ilsco, De-Ox, ITT Noalox, Blackburn Contax or approved equal.

I. Use suitable conduit caps to protect installed conduit against entry of dirt and moisture. The use of duct tape or any other tape shall be prohibited.

J. Use watertight hubs to fasten conduit to metal boxes, etc. in wet or damp locations per the National Electrical Code.

K. Size conduits as required by the National Electrical Code for the number and sizes of wires to be drawn into the conduit.

L. Where applicable, aluminum conduit, straps, and struts shall not be in direct contact with concrete. Provide a neoprene washer between the two materials.

M. PVC conduit shall not be installed above grade level, above concrete slab level, or for any exposed installations unless specified.

N. Conduit system shall be swabbed clean prior to installation of conductors.

O. Ground conduits in accordance with the National Electrical Code and Specification 26 05 26, GROUNDING & BONDING FOR ELECTRICAL SYSTEMS.

P. Install manufactured PVC coated aluminum conduit elbows for stub-ups at poles and equipment. Encase elbows for stub-up ducts throughout length of elbow.

Q. Complete raceway installation before starting conductor installation.

R. Cut conduit perpendicular to the length. For conduits 2” trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

S. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

T. Arrange stub-ups so curved portions of bends are not visible above finished slab.

U. Install no more than the equivalent of four 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction or where conduit penetrates through a floor, wall, or transitions from underground.

V. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

W. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

X. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Y. Install conduit drain assemblies in outside or underground conduits to provide for draining.

3.03 CONDUITS THROUGH CONCRETE:

A. Conduit stubbed-up through concrete and under free standing enclosures located such as a motor control center, shall include an insulated throat grounding bushing threaded to the conduit termination. No fiberglass shall be exposed to daylight or be installed such that any

portion is out of concrete housekeeping pad or duct bank. Contractor shall properly tape PVC coated aluminum conduit where it transitions to PVC conduit in underground concrete encased duct banks so that no aluminum conduit is in contact with concrete encasement. Tape shall be manufactured by Scotch or approved equal. Coordinate with tape manufacturer for type of tape to use for the installation.

B. Conduit passing through concrete shall be PVC coated aluminum. Conduit shall extend 12" above concrete transition. Where conduit transitions from below concrete into a duct bank, the conduit shall be PVC coated aluminum to the elbow.

C. Conduit extending into concrete shall not be closer than 3" from adjacent conduit and shall not be closer than 1" from any reinforcement bars.

3.04 HAZARDOUS LOCATION CONDUIT INSTALLATION

A. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

1. Sealing fittings shall be filled with compound rated for hazardous locations Class I, Div.1 or Class 1, Div. 2 for conduits as indicated on the drawings.

B. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

3.05 EXPANSION FITTING INSTALLATION

A. Expansion Fittings:

1. Expansion fittings used with aluminum conduit shall be installed in the following locations:

a. At construction joints.

b. In conduit runs longer than 100'

c. Transitions from underground to above elevation (exposed).

2. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

3. Install expansion fittings at all locations where conduits, concealed or surface mount, cross building, structure, construction and seismic expansion joints.

4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

5. Acceptable expansion/deflation fittings made of neoprene in outdoor applications shall have aluminum lagging over the neoprene held in place with stainless steel tie-wraps.

3.06 LIQUID TIGHT FLEXIBLE CONDUIT INSTALLATION

A. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFNC in damp or wet locations not subject to severe physical damage.

3.07 JUNCTION BOX AND PULL BOX INSTALLATION

A. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

B. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

C. Drilling holes in boxes to support the box shall not be allowed.

3.08 INSTALLATION OF UNDERGROUND CONDUIT

A. Concrete Encased Conduit:

1. Duct banks routed below building slabs or any equipment pad shall be steel reinforced concrete encased.
2. Excavate trench bottom to provide firm and uniform support for conduit.
3. After installing conduit and concrete, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 23 33 "TRENCHING AND BACKFILL".
4. At the transition from underground and or from concrete, protect conduit from mechanical damage by extending PVC coated rigid aluminum conduit a maximum of 12" and a minimum of 4" into the earth or concrete at the transition.
5. Contractor shall properly tape PVC coated aluminum conduit where it transitions to PVC conduit in underground concrete encased duct banks so that no aluminum conduit is in contact with concrete encasement. Tape shall be manufactured by Scotch or approved equal. Coordinate with tape manufacturer for type of tape to use for the installation.
    a. Couple PVC coated aluminum conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
7. For installation of conduits to be used by electric utility, coordinate with the utility for exact requirements
8. Conduit which is below the finished grade shall be PVC schedule 40, except where indicated on the plans or noted otherwise.

9. Bury underground conduit a minimum of 18" deep to the top of the concrete encasement for 600V duct banks. Backfill buried conduit banks with material which is free from large rock, paving material, or large angular substance.
10. Install underground conduit with the conduit duct bank dimensions shown on the plans. Adhere to conduit spacing by using spacers at intervals to ensure that proper spacings are maintained.
11. The concrete shall be red in color. Apply dye in concrete truck, sprinkling dye on top of the duct bank after concrete placement is prohibited. Place 3” CMU blocks under rebar cage to suspend rebar off of the bottom of the trench so that it does not contact the soil and is completely encased in the concrete envelope when concrete is placed.
12. Contractor shall install duct bank spacers a minimum of every 5 feet.
13. Underground horizontal conduit bends shall have a minimum 2' bend radius. Underground conduit bends which are 45° or more and which are on conduits of 2" or greater shall utilize factory-coated rigid aluminum bends.
    a. PVC conduits requiring less than 30° bend may be bent using a hot box, but deformation of the conduit such that the internal cross-sectional area (at the bend) is compromised will not be allowed.

3.09 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2” sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

3.10 SIZING AND INSTALLATION OF WIREWAYS, PULL BOXES AND JUNCTION BOXES

A. The Contractor shall be responsible for providing and sizing all wireways, pull boxes and junction boxes per the National Electrical Code (NEC) Article 314 and all other relevant sections of the NEC.

B. Install Products in accordance with manufacturer's instructions.

C. Use screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.

D. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

E. Wireway Supports: Per manufacturer's recommendations.

F. Close ends of wireway and unused conduit openings.

G. Use separate pull boxes and junction boxes for electric power, control and communication systems.

H. Install pull boxes in interior conduit at not more than 100' apart when conduit runs are not broken by junction or outlet boxes.

I. Pull and junction boxes shall be accessible and not buried.

J. Support boxes independently of conduit except for cast boxes that is connected to two rigid metal conduits, both supported within 12" of box.

K. Box shall be mounted using mounting lugs. Drilling through the box to mount is prohibited. Any box drilled to mount will be rejected and shall be removed and replaced at the Contractor's expense.

3.11 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.12 CONDUIT TERMINATIONS

A. Conduit terminations at enclosures shall maintain the NEMA rating of the enclosure. Conduit terminations damaging enclosures shall not be permitted. Damaged enclosures will not be accepted and shall be replaced at the Contractor's expense.

B. Use grounding myers hubs for termination of conduits into enclosures.

C. Locknut termination of conduits shall not be used on this project except were liquid tight fittings require locknuts to maintain UL listings. Locations utilizing liquid tight fittings shall include a stainless steel banded sealing gasket. Damaged bands or gaskets due to overtightening shall be replaced by the Contractor.

D. For exterior, wet locations, and where conduit enters from exterior or wet locations, conduit terminations shall not penetrate the top of NEMA 4X enclosures. Enclosures with top penetrations shall be removed and replaced with conduits re-routed for side or bottom penetration at Contractor's expense. If conductors have been installed and are too short to accommodate the re-routed conduit, then they shall be removed and replaced at the Contractor's expense.

E. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

F. Use suitable conduit caps to protect installed conduit against entry of dirt and moisture. The use of duct tape or any other tape shall be prohibited.

G. Conduits terminating inside an air conditioned space from outside shall be sealed to prevent moisture/condensation from entering the enclosure.

H. Install raceways square to the enclosure and terminate at enclosures with Myers hubs. Install Myers hub hand tight plus 1/4 turn more.

3.13 JUNCTION BOX INSTALLATION

A. Junction boxes shall be installed so they are accessible from the front.

B. Junction boxes shall have terminal strips/distribution blocks for splicing conductors where approved by the Engineer or as shown/specified on the plans. Terminal strips shall be manufactured by Allen-Bradley, Phoenix Contact or approved equal. Distribution blocks shall be per Section 26 05 19, Low Voltage Electrical Power Conductors & Cables. No top entry in junction boxes with a terminal strip.

C. Use watertight hubs to fasten conduit to metal boxes, etc. in wet or damp locations per the National Electrical Code.

D. Metallic Junction boxes shall be grounded with NEC approved grounding fasteners and by means allowed by the enclosure manufacturer. Enclosures drilled for grounding fasteners that do not meet code shall be replaced at the cost of the Contractor.

END OF SECTION

26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install a complete cable tray. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

B. The Contractor shall provide splice plates as required to join the existing cable tray to the new cable tray. Field verify existing conditions and take field measurements as required.

1.02 QUALITY ASSURANCE - ACCEPTABLE MANUFACTURERS

A. Products shall comply with the specifications and the following Manufacturers will be acceptable:

1. MP Husky
2. B-Line
3. Cope
4. PW
5. No Equal

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management ” and shall include:

1. Cable tray, cable tray routing in AutoCAD format, fittings, hangers, and fire stop pillows.

a. Calculations shall be provided for loading and deflections as part of the submittal. Calculations shall be submitted in a format that is verifiable by hand-calculation by the Engineer. Cable tray installed without meeting the above requirements will be rejected. The information required above shall be provided with the cable trays initial submittal. No exceptions.

1.04 STANDARDS

NEMA VE1	Metal Cable Tray Systems
NEMA VE2	Cable Tray Installation Guidelines

2.00 PRODUCTS

2.01 MATERIALS

A. CABLE TRAY: aluminum, conforming to the requirements of NEMA VE 1, Class 16C. Support spacing for cable tray shall be per NEMA and the manufacturer’s requirements to maintain specified NEMA class designation. The cable tray shall comply to the following:

1. Inside Depth: 5” Loading depth, Outside 6”.

2. Inside Width: as indicated.
3. Straight Section Rung Spacing: 9".
4. Inside Radius of Fittings:
    a. 12” radius for cable trays 18” wide and smaller.
    b. 24” radius for cable trays 24” wide and larger.

3.00 EXECUTION

3.01 INSTALLATION

A. Install the cable tray according to the Manufacturer's printed instructions. Support the cable tray on trapeze type hangers, 1-5/8" x 1-5/8" channel or 1/2" diameter, threaded, rod hangers. All supporting devices shall be 304 or 316 stainless steel including nuts and washers. Maximum spacing shall be 16’-0”. Coordinate with structural reinforcement.

B. Connect sections of the cable tray together with edges free from burrs and sharp projections. Use expansion connectors where indicated by NEMA VE1.

C. Provide bonding continuity between cable tray sections and fittings according to the Manufacturer's instructions.

D. Install a bare ground conductor routed along the outside of the tray rails the full length of all cable tray runs and bond each tray section, bond to all drop conduits and to the ground of every enclosure fed by the tray system.

E. Provide a grounding jumper between each cable tray section and ground cable tray per the National Electrical Code.

F. Provide aluminum ladder drop-out at end of tray runs to prevent damage to cable insulation.

G. Cable tray shall be anchored to prevent both horizontal and vertical movement.

H. Provide #4/0 bare copper ground conductor the full length of the cable tray, bonded to each section and to all enclosures in accordance with the National Electrical Code and Section 26 05 26, “Grounding & Bonding for Electrical Systems”.

I. For cable tray penetrations through fire-rated walls, provide fire barrier self-locking pillows manufactured by 3M, Nelson, or approved equal.

J. Do not support conduit drops from the cable tray. Provide separate conduit supports from the ceiling or wall or trapeze supports which support the tray.

END OF SECTION

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

1. Record Data:

a. Product Data to include cut sheets for each electrical identification product to be used on the project. Provide example of labeling for Owner/Engineer approval prior to beginning any work.

1.03 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, are not acceptable.

2.00 PRODUCTS

2.01 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. All markings to labels, schedules, tags or nameplates shall be machine printed only. Hand printing is prohibited. Circuits shall be tagged at terminations (both ends), in pull boxes, cabinets, and enclosures as follows:

1. Tags relying on adhesives or tapes-on markers are not acceptable, unless noted otherwise.
2. Hand written tags are not acceptable.
3. Provide conductor tags for conductors No. 10 AWG and below with legible permanent sleeve of yellow or white PVC with machine printed black marking, Raychem TMS sleeves or approved equal.
4. Provide tags for cables and for conductors No. 8 AWG and larger consisting of permanent nylon marker plates with legible designations hot stamped on the plate. Attach these marker plates to conductors and cables with stainless steel wire wraps. Tags shall be Raychem TMS-CM cable markers or approved equal.
5. Tags shall be imprinted with panelboard and panelboard position number (e.g. LA3-23) for conductors fed from panelboards. Other conductors shall have tags imprinted with the MCC which feeds the conductors (e.g. MCC 1).
6. Switchlegs shall have the designation described above on their tags, plus an “S” suffix. Travelers shall have the designation described above on their tags, plus a “T” suffix.
7. Where more than one neutral is present with a group of conductors, a tag shall be applied to each neutral indicating which phase conductors are served by each neutral (e.g. HA-2, 4, 6).

2.02 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.05 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Attach plates to equipment with stainless steel screws. Provide an O-ring for screws on NEMA 4X enclosures, O-rings shall maintain the integrity and NEMA 4X rating for enclosures.

B. NAMEPLATES:

1. For indoor applications with Air Conditioning: Plastic, white 1" letters on black background, on the front of each door on the switchgear; identifying the compartment contents for each compartment.

2. All other applications: Plastic, white 1" letters on black background, on the front of each door on the switchgear; identifying the compartment contents for each compartment.

3. Attach nameplates with a stainless steel screw and nut at each end of the nameplate. Adhesive backed nameplates shall not be installed.

4. Label that includes tag designation shown on Drawings for the transformer, switchgear, panelboards or other electrical equipment.

2.06 CONDUIT IDENTIFICATION PLATE

A. A conduit identification plate shall be installed on all power, control, instrumentation and communications conduits at the end of each run and at the conduit ends inside intermediate junction and pull boxes, manholes, handholes, etc. Conduit plates shall be installed before conductors are pulled into the conduits. Exact identification plate location shall be coordinated with the Owner/Engineer at the time on installation. The conduit identification tags shall identify the cable numbers as shown on the FNI plans and the "to" and "from" information. Coordinate with Owner for exact requirements for plate material and type. Provide an example to Owner/Engineer as a formal submittal for approval prior to the installation. Attach conduit identification plate with stainless steel tie wraps or stainless steel wire.

3.00 EXECUTION

3.01 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with stainless steel mechanical fasteners appropriate to the location and substrate.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification. Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be field applied for sizes larger than No. 8 AWG

b. Colors for 120/240V Circuits:

1). Phase A: Black

2). Phase B: Red

3). Neutral: White

4). Equipment Grounding Conductor: Green

c. Colors for 208/120-V or 240V/120V, 3-phase Circuits:

1). Phase A: Black.

2). Phase B: Red.

3). Phase C: Blue.

4). Neutral: White

5). Equipment Grounding Conductor: Green

d. Colors for 480/277-V Circuits:

1). Phase A: Brown.

2). Phase B: Orange.

3). Phase C: Yellow.

4). Equipment Grounding Conductor: Green

e. Colors for 5,000-V Circuits:

1). Phase A: Brown with a purple stripe.

2). Phase B: Orange with a purple stripe.

3). Phase C: Yellow with a purple stripe.

4). Equipment Grounding Conductor: Green

f. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3. Identifying line shall be continuous along the entire underground route.

C. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    a. Power transfer switches.
    b. Controls with external control power connections.

D. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
    a. Indoor Equipment: stainless steel screws and nuts, engraved and laminated nameplates. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Fasten labels with appropriate mechanical fasteners and gaskets that do not change the NEMA or NRTL rating of the enclosure and void the U.L. listing of the enclosure.
2. Equipment to Be Labeled:
    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label and placed in a clear plastic sleeve.
        1). For Panelboards located at the Electrical Building, Pump Station and those located within the Generator enclosure.
    b. Enclosures and electrical cabinets.
    c. Starters
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    g. Motor-control centers.
    h. Enclosed switches.

i. Enclosed circuit breakers.

j. Enclosed controllers.

k. Push-button stations.

l. Contactors.

m. Monitoring and control equipment.

n. UPS equipment.

o. Conduits

p. Power Factor Correction Capacitors

q. Variable Frequency Drives

r. Generators

s. Transfer Switches

t. Pull boxes, junction boxes, concrete pull boxes, manholes and hand holes.

END OF SECTION

26 05 73.01 ELECTRICAL POWER SYSTEM STUDIES

1.00 GENERAL

1.01 DESCRIPTION

General: This section specifies that the Contractor prepare a short circuit and protective device coordination study, load flow, motor starting study, and an arc flash hazard analysis for the electrical power system as shown on the plans for the complete electrical system at the Colliers Ferry Raw Water Pump Station site.

No equipment provided under this Contract is to be energized until the Power System Studies have been approved by the Engineer, the protective relays and breakers have been set per the Short Circuit and Relay Coordination Study and the arc flash labels have been installed on the equipment. No exceptions.

Short Circuit and Protective Device Coordination Study, Arc Flash Analysis, Load Flow Study, and Motor Starting Study

The studies shall provide an evaluation of the electrical power system and the model numbers and settings of the protective relays or devices and metering or motor monitoring devices for setting by the Contractor. The Studies shall include settings for all protective relays and circuit breakers, including breakers mounted in generator, power meters and electric system monitoring for both devices provided under this contract and for the existing devices. The Contractor shall obtain any needed data or information for the electrical equipment from Contract Documents, various suppliers, and from conducting his own field investigations.

A. Scope:

1. The Contractor is responsible for providing all pertinent information necessary for the successful completion of the Short Circuit and Protective Device Coordination Study, Load Flow and Motor Starting Study, and Arc Flash Analysis. All cable and raceway data, data from all new and existing electrical equipment - Switchgear, motor control centers, transformers, generators, panelboards, and separately mounted fuses, starters or circuit breakers shall be obtained by the Contractor. Obtain all existing or new protective device information to include all present settings. The Contractor shall obtain any needed data or information from Contract Documents, various suppliers, the Electric Utility and from conducting his own field investigations. The data obtained shall be organized and submitted to the Engineer to show that all the necessary data gathering work has been done.
2. Calculations shall utilize actual X/R and three phase short circuit values obtained by the Contractor from the Electric Utility. The use of infinite bus fault current calculation is not acceptable.
3. The Contractor shall redo the Power System Studies if any changes are made during the field testing checkout and/or start-up and shall re-submit the updated study for engineer approval.

4. Provide a complete short circuit study. Include three phase and phase-to-ground calculations. Provide an equipment interrupting or withstand evaluation based on the actual equipment and model numbers provided on this project. Generic devices are not acceptable. Normal system operating method, alternate operation, and operations that could result in maximum fault conditions shall be thoroughly addressed in the study.
    a. The study shall assume all motors operating at rated voltage with the exception that motors identified as "standby" shall not be included.
    b. Electrical equipment bus impedance shall be assumed zero.
    c. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at the electrical equipment busses.
    d. The Study shall be performed using actual available short circuit currents available and system impedances as obtained from the Electric Utility and Generator manufacturer. An assumption of infinite bus for the purposes of the Study is not acceptable.
    e. Study shall use actual motor X/R and subtransient reactance data obtained from equipment suppliers.
5. A protective device coordination study shall be performed to determine appropriate relay settings. The study shall include all electrical equipment provided under this contract and any up-stream equipment that has an impact on the coordination study. The study shall show transformer damage curves, generator damage curves, cable short circuit withstand curves and motor curves. Include all medium and low voltage switchgear, distribution switchboards, motor control centers, starters, and panelboards main circuit breakers. Complete the short circuit study down to the main breaker or main lugs on all 120/240V and 208Y/120V panelboards. Panelboard branch circuit devices need not be considered. The phase over current and ground-fault protection shall be included as well as settings for all other adjustable protective devices. All motor monitoring relays and protective or monitoring devices that are a part of a supplier's equipment (such as soft starters, switchgear) shall be in included. Include the last protective device in the Electric Utility's system feeding each facility being considered.
6. Provide Time-Current Curves on 11X17 log-log paper. Do not put more than one branch of protective devices on any one coordination curve. Include a one-line diagram and the names of each protective device in the branch. Use the names designated in the Contract Documents. Include motor and transformer damage curves, and cable short circuit withstand curves. Coordination study time-current curves (11x17 log-log type) including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker. Organize the curves as specified here in. Ground fault time current curves shall be on a separate sheet.
7. An equipment evaluation study shall be performed to determine the adequacy of the fault bracing of all bus from the panelboard level up to the main Switchgear or protective device. Include circuit breakers, controllers, surge arresters, busway, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents.
8. Provide arc flash hazard analysis in accordance with the applicable NFPA, ANSI, and IEEE standards.

9. The studies shall be performed, sealed and signed by a Registered Professional Engineer licensed in the state of Texas.
10. Any problem areas or inadequacies in the equipment shall be promptly brought to the Engineer's attention.
11. Use industry standard short circuit software, SKM CAPTOR and DAPPER or an equal approved by the Engineer.
12. The report shall include a comparison of short circuit duties of each bus to the interrupting capacity of the equipment that is protecting that bus.
13. The report shall include all data that was used as input to the report. This data shall include cable impedance, conduit type, source impedance, equipment ratings, motor X/R and subtransient reactance data, etc.
14. Provide and program all settings for all power meters, motor protection relays, feeder protection relays, etc.
15. The Contractor shall coordinate with the Utility, Lubbock Power & Light for electrical data required for the studies.

1.02 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NFPA 70E	Handbook for Electrical Safety in the Workplace
IEEE 1584	IEEE Guide for Performing Arc-Flash Hazard Calculations
NEC	National Electrical Code

1.03 SCHEDULE

A. The report shall be provided to the Engineer NO LATER THAN 60 days before the equipment is shipped to the Work site. SHIPMENT AND DELIVERY OF EQUIPMENT WILL NOT BE ACCEPTED AT THE JOBSITE UNTIL THE STUDY HAS BEEN COMPLETED, SUBMITTED AND APPROVED BY THE ENGINEER.

1.04 SUBMITTAL PROCEDURES

Submittal Procedures shall be in accordance with Section 01 30 00, “Document Management ” and shall include:

A. Shop Drawings:

1. Short Circuit and Protective Device Coordination Study. Time current curves shall be on 11x17 log-log type paper. The 11x17 paper with the TCC shall also include a one-line diagram for the branch that the TCC on that sheet corresponds with. The Contractor can provide time current curves on 8 ½ x 11 log-log type paper as a supplement but not as a replacement.

2. Provide a list of all recommended settings for all power meters, motor protection relays, feeder protection relays, circuit breakers, etc.

3. Load Flow Study

4. Motor Starting Study

5. Contractor shall coordinate with the starter manufacturers for all data required to perform the motor starting analysis. The preliminary starting analysis shall determine the maximum inrush allowed when starting the motor to not drop out the loads under the worst operating conditions.

6. Arc Flash Hazard Analysis

a. Provide a color copy of project specific Arc Flash labels for each panelboard, switchboard, switchgear, disconnect, Motor Control Center, VFDs, starters, transfer switches, including all existing electrical equipment – switchgear, starters, motor control center, panelboards, starters, etc.

b. Data sheet of arc flash label.

c. Provide a copy of the one-line diagram color-coded to show the incident ranges at each bus. The one-line shall be on 11x17 paper.

1). The one-line shall also include the information specified in section 2.03 below.

B. After the report and one-line has been approved, provide a color copy in PDF format of the finalized 11x17 one-line diagram for each site to the Contractor for the Contractor’s use to frame in the electrical room as specified in section 26 05 00, “Common Work Results for Electrical”. The one-line shall reflect all changes made including but not limited to changes made during construction

C. The Contractor shall redo the Power System Studies if any changes are made during the field testing checkout and/or start-up. The Contractor shall re-submit the Power System Studies for Engineer Approval. The Studies shall include an updated copy of the color copy Arc Flash Labels.

D. A CD with all SKM input files and a PDF of all output files is required for both the preliminary and final power system studies Submittal Procedures.

1. Two Software copies of actual power systems computer program project data files burned in on a CD. The Contractor shall provide an electronic copy on a CD-ROM of all files used to develop the electrical system model in the power system analysis program and all files for the written study analysis and summary data tables. For instance, if SKM software is used for the power system studies, then the SKM files shall be burned in on a CD-ROM and provided to the Owner/ Engineer. This shall include any library files used for circuit breakers, fuses, etc. for the power system analysis.

2.00 EXECUTION

2.01 GENERAL

A. Provide a short-circuit and protective device coordination study load flow study, and arc flash hazard analysis on the electrical power distribution system, as specified. The studies shall be performed in accordance with IEEE Standards 141 and 242, IEEE 1584, ANSI, and the NEC and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010. The studies shall be performed using actual equipment data for all equipment. The coordination studies shall use the data from the manufacturer of protective devices.

2.02 QUALIFICATIONS

A. The studies shall be performed by a consultant who is regularly engaged in power system studies. A Licensed Professional Engineer with proficiency in electrical power engineering shall conduct the studies and shall seal and sign the studies. The Professional Engineer shall be licensed to practice engineering in the State of Texas. A study submitted without a Professional Engineer's seal will not be reviewed and returned Not Approved, Revise & Resubmit. **EQUIPMENT MANUFACTURERS SHALL NOT BE ALLOWED TO PERFORM THE STUDIES, NO EXCEPTIONS.**

B. Acceptable Power System Study Providers:

1. Strategic Engineering – Jeff Wilbanks, P.E. (214) 679-0092
2. Coordinated Power Systems, Inc. – Robert Stockinger, P.E. (414) 425-5993
3. All others shall submit qualifications to the Owner and the Engineer for review and approval prior to bid submittal no later than one week after bid advertisement date. Any submittals after this time period shall not be evaluated. Qualifications shall include Power Systems Studies providers who have had at least 5 years of successful experience in the performing studies of similar projects with a generator and pump station configurations. Qualifications shall include a list of similar projects within the last 5 years with the name of the project and contact information of the Owner**.**

2.03 OPERATING SCENARIOS

A. The following Operating Scenario(s) shall be included in the study:

1. Normal Utility Power

a. At the Coillier's Ferry Raw Water Pump Station:

1). The maximum number of pumps that can run at the Pump Station at a time is 3 pumps plus miscellaneous loads. The pump station shall be fed from a single service transformer.

2). The minimum number of pumps that can run at the Pump Station at a time is 1 pumps plus miscellaneous loads.

2. Back-up Generator Power

a. With Generator only providing power for the Collier's Ferry Raw Water Pump Station:

1). The maximum number of pumps that can run at the Pump Station at a time is 3 pumps plus miscellaneous loads. The pump station shall be fed from a single service transformer.

3. The studies shall include and model the different operating configurations that may be encountered at the sites. This includes different transformers operating individually with various main and tie breakers open and closed. The studies shall clearly identify the particular operating configuration being evaluated.

2.04 SHORT CIRCUIT STUDY

A. The Contractor shall be responsible for obtaining and verifying all data needed to perform the study.

B. As a minimum, each short circuit study shall include the following:

1. One-Line Diagram:

a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.

b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

c. Power and voltage ratings, impedance, primary and secondary connections of all transformers. Use the ratings (ie. Impedence, X/R, etc.) of the actual transformers being provided where available.

d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.

e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators. Obtain data on the actual equipment being provided. Generic or average data numbers are not acceptable.

f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors. Provide short circuit studies using each source of power separately. The study shall determine if there is sufficient short circuit current to adequately cause interruption of a protective device using the weaker power source (typically local generation), and shall determine if the equipment can safely interrupt the fault if the greater power source is connected. Additional short circuit calculations shall include emergency as well as normal switching conditions as well as normal and emergency power sources described here in.

   1). Show short circuit calculations listing short circuit levels at each bus. Provide the same data in tabular from.

g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc shall be included.

h. The time-current setting of existing adjustable relays and direct-acting trips, if applicable.

i. One-Line showing available fault current at each bus all the way down to the 120/240V and 208Y/120V panelboards.

2. Impedance Diagram:

   a. Available MVA or impedance from the utility company.

   b. Local generated capacity impedance.

   c. Bus impedance.

   d. Transformer and/or reactor impedances.

   e. Cable impedances.

   f. Equipment impedances.

   g. System voltages.

   h. Grounding scheme (resistance grounding, solidly grounding, or no grounding).

   i. Motor contribution assuming the new and existing motors as shown on the plans all running at the same time.

3. Calculations:

   a. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.

   b. Calculate the maximum and minimum fault currents.

   c. A discussion section evaluating the adequacy or inadequacy of the equipment method of calculation and formulas used such that all calculations can be verified manually by the Engineer, with recommendations as required for improvements to the system.

   d. Any inadequacies shall be called to the attention of the Engineer and recommendation made for improvements.

2.05 PROTECTIVE DEVICE COORDINATION STUDY

A. As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

1. The time-current coordination analysis shall be performed with aid of a digital computer.

a. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing, but still maintain a low incident energy level. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.

2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.

3. Time-current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

6. Sketch of bus and breaker arrangement.

2.06 ARC FLASH HAZARD ANALYSIS

A. The study shall be performed in accordance with the NEC and all applicable OSHA, ANSI, and IEEE 1584-2018 standards.

B. The Contractor shall adjust all adjustable time-current devices such that the trip settings lower the arc flash exposure and minimizing the clearing time. However, the Contractor shall adjust the time-current devices to avoid nuisance tripping.

C. The Contractor shall utilize fault current values from the short circuit analysis to determine the Incident energy, limited approach boundary, restricted approach boundary, prohibited approach boundary and appropriate PPE required.

D. The Contractor shall provide project specific arc-flash labeling. The arc-flash labeling shall be placed on the outside of the cover of the switchgear, motor control centers, combination motor starters, panelboard, switchboard, distribution panel, and all electrical panels, etc. such that it can be read without opening the electrical equipment. Mount arc-flash labels a maximum of 6’-6” AFF, include the housekeeping pad in the mounting height. The Contractor shall provide arc-flash labeling on all existing panelboards, switchboards, distribution panel, etc. where breakers are added or work is performed in or on the electrical equipment.

E. Arc Flash Labels shall be chemical resistant, UV resistant, water resistant, scratch resistant, and made of 3.0 mil vinyl tape as manufactured by DuraLabel, Brady or approved equal. The lettering shall be performed by thermal transfer print.

1. Arc Flash labels and label lettering shall be sized large enough to be legible at a distance outside the hazard area.

2. Arc Flash Labels shall be placed on the door(s) of the room if the hazard area reaches or extends beyond the electrical room door(s).

3. The arc flash label shall include a DANGER header when the incident energy is above 40cal/cm^2, and a WARNING header for all other incident energy levels.

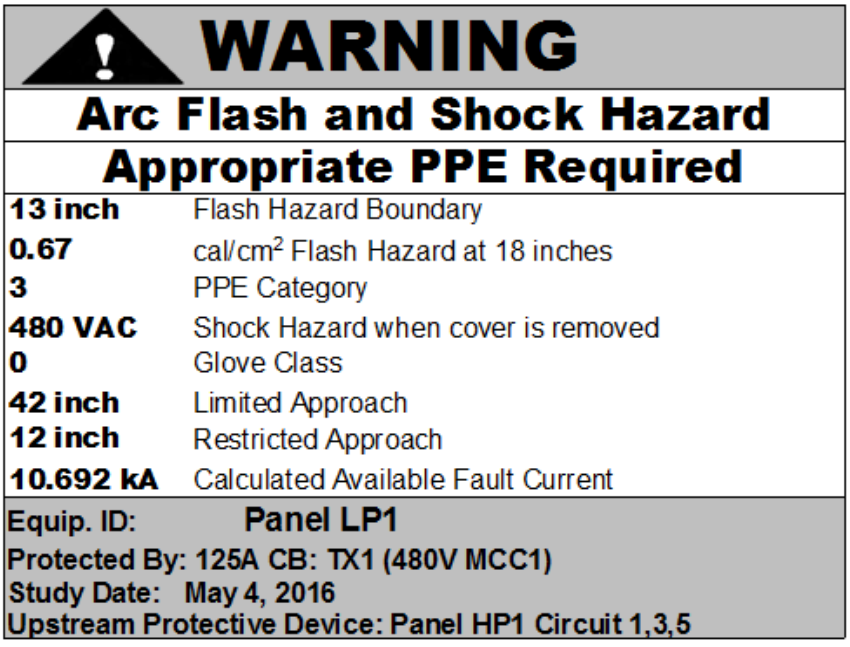
F. To ensure a safe workplace, and that the labeling meets NEC, OSHA, IEEE, and NFPA requirements, use specialized arc flash software to calculate protection boundaries. These protection boundaries shall include the Flash Protection Boundary, Limited Approach Boundary, Restricted Approach Boundary and the Prohibited Approach Boundary.

G. Arc-flash label shall be provided all the way down to the 120/240V and 208Y/120V panelboards.

H. The arc-flash analysis shall be based on calculated fault from the Short Circuit Study at each respective bus. The arc-flash software program shall be used to calculate the available arcing fault at each bus in the system, the resultant flash protection boundary based on the applicable protective device operating times and the associated incident energy that workers may be exposed to at the specified working distances.

I. The report shall include the following information: Arc-flash evaluation table, arc-flash and shock hazard label definitions, arc-flash evaluation information, arc-flash and shock hazard labels and definitions of terms used in the arc-flash hazard analysis.

J. Arc Flash labels shall be similar to the following example:



2.07 LOAD FLOW STUDY

A. SCOPE: Determine the active and reactive power, voltage, current, and power factor throughout the electrical system. Provide an analysis of all possible operating scenarios.

B. PROCEDURE: The load flow study shall be performed in accordance with the recommended practices and procedures set forth in IEEE 399.

C. STUDY REPORT: Results of the load flow study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study.
2. Tabulation of data used to model the system components and a corresponding one-line diagram.
3. Description of scenarios evaluated and the basis of each.
4. Tabulation of power and current flow versus equipment ratings. The tabulation shall identify percentage of rated load and the scenario for which the percentage is based. Overloaded equipment shall be clearly noted.
5. Tabulation of system voltage versus equipment ratings. The tabulation shall identify percentage of rated voltage and the scenario for which the percentage is based. Voltage levels outside the ranges recommended by equipment manufacturers, IEEE C84.1 or other appropriate standards shall be clearly noted.
6. Tabulation of system real and reactive power losses with area of concern clearly noted.
7. Provide One-line showing voltage at major busses down to the 120/240V and 208Y/120V panelboards.
8. Conclusions and recommendations.

2.08 Motor Starting Study

A. The motor starting study shall provide an evaluation of the electrical power system when starting the motors for all operating scenarios. The motor starting study shall evaluate all different possible operating scenarios under the worst case starting conditions. The Contractor shall coordinate with the electrical equipment manufacturers and obtain all information required to perform the motor starting analysis. The preliminary starting analysis shall determine the maximum inrush allowed when starting the motors to not drop out the site loads under the worst operating conditions.

B. Scope:

1. Contractor shall provide a motor starting/load flow study for the work performed at the site. The study shall evaluate all possible operating scenarios. See electrical plans for detailed one-line diagram of the electrical distribution system. The study shall show the worst case conditions meets or exceeds the voltage flicker requirement of IEEE/NEMA standards and does not drop out the site loads. The Contractor shall coordinate with the Local Utility and Owner for all voltage flicker requirements and is responsible for obtaining all pertinent data from the Local Utility/ Owner and other equipment manufacturers to perform the study.
2. Contractor shall obtain any information required for the motor starting/load flow study including utility available fault current, utility system impedance, motor data (i.e., sub transient reactance, etc.), transformer data (i.e. impedance, X/R, etc.), cable data, etc.
3. The study shall be submitted to the Engineer and approved prior to final approval of the electrical equipment shop drawings and release of any electrical equipment for manufacturing.

4. The study shall include as a minimum the following:
    a. Single line diagram showing voltage at all major busses down to the 120/240V and 208Y/120V panelboards.
    b. Bus Voltage and power flow
    c. Information on the computer program used for the study and also shall include a general discussion of the procedure, items, and data considered in preparing the study.
    d. Description and analysis of all results.
    e. Suggested changes to the equipment selection that will result in improved system performance.
5. The study shall be performed, sealed and signed by a Registered Professional Engineer licensed in the state where the electric equipment is to be installed.

END OF SECTION

26 09 23 LIGHTING CONTROL DEVICES

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment and incidentals necessary to install contactors. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 30 00, “ Document Management” and shall include:

1. Shop Drawings:

a. Project specific control schematic/diagram for lighting contactors. Submittals without a project specific control schematic/diagram will be rejected and not approved. Diagram shall be done in CAD. Handwritten diagrams are not acceptable.

b. Product Data Sheet

c. Bill of Material

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. STANDARDS: The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ANSI/NEMA ICS 6

2. NEMA ICS 2

C. ACCEPTABLE MANUFACTURERS: Equipment shall comply with the specifications and shall be by the following manufacturers:

1. Lighting contactors:

a. Eaton

b. Siemens

c. Square D; Schneider Electric.

2. Photocells:

a. Grasslin Controls Corporation; a GE Industrial Systems Company.

b. Lithonia Lighting; Acuity Lighting Group, Inc.

c. Square D; Schneider Electric.

2.00 PRODUCTS

2.01 OUTDOOR PHOTOELECTRIC SWITCHES

A. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.

2. Time Delay: 15-second minimum, to prevent false operation.

3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.

4. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.02 LIGHTING CONTACTORS

A. Description: Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Contactor shall be the number of poles required, rated 30 amps at 480VAC or as indicated on the plans. Lighting contactors shall be Square D Class 8903 Type L, or approved equal. Lighting contactors shall be mounted in a NEMA 1, 12 gauge steel enclosure suitable for indoor installation. Coil operating voltage shall be as indicated on plans.

3. Indicating Lights, Switches, and Pushbuttons: Heavy duty and oil tight (30 mm); Square D Class 9001 or approved equal. Pilot lights shall be push to test (LED type) and shall be Square D SK or approved equal.

4. Provide a print pocket pouch with the project specific control schematic drawings on the inside of the Lighting Contactor door. The control schematic drawings shall be the final version of the drawings and shall include any field revisions made during start-up.

3.00 EXECUTION

3.01 PHOTOELECTRIC SWITCH INSTALLATION

A. Furnish and install photocells where indicated on the plans. Cells shall face a northerly direction.

3.02 CONTACTOR INSTALLATION

A. Mount lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.03 IDENTIFICATION

A. Identify components and power and control wiring according with Section 26 05 53, “Identification for Electrical Systems”.

1. Identify controlled circuits in lighting contactors.

2. Identify circuits controlled by photoelectric and occupancy sensors at each sensor.

3. Externally visible, permanent nameplates shall be provided to identify each switch, indicating light, etc. Equipment and terminal blocks shall be suitably identified. This shall include items on the back side of doors and panel mounted items. Nameplates shall be black with white lettering and attached with stainless steel screws.

B. Label contactors with a unique designation.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

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26 22 13 LOW VOLTAGE DISTRIBUTION TRANSFORMERS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install transformers. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

1.02 QUALITY ASSURANCE

A. Transformers shall comply with the specifications and shall be produced by the following Manufacturers:

1. Cutler-Hammer
2. General Electric
3. Square D
4. No Approved Equal

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

1. Bill of Material
2. Equipment Data Sheets showing impedance weights, dimensions, etc. for each transformer.
3. Product data on specified product documenting the following:
    a. Dimensions
    b. Weight
    c. KVA
    d. Voltage
    e. % Impedance
    f. Magnetizing current magnitude and duration
    g. Taps
    h. Insulation Class
    i. Sound Level
    j. Wiring Diagram
    k. Installation Instructions

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

ANSI/IEEE C57.96	Distribution and Power Transformers, Guide for Loading Dry-Type appendix to ANSI C57.12 standards
ANSI/IEEE C89.2	Dry Type Transformers for General Applications
IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and / or Resin-Encapsulated Windings
IEEE C57.12.91	Test Code for Dry-Type Distribution and Power Transformers
	UL 506, Specialty Transformers
NEMA/ANSI ST20	Dry type transformers for General Applications
IEEE	Institute of Electrical and Electronic Engineers
NEMA TR1	Transformers, Regulators and Reactors
NEMA TP-1 2002	Guide for Determining Energy Efficiency for Distribution Transformers

2.00 PRODUCTS

A. DRY TYPE TRANSFORMERS

1. Provide dry type, 3-phase, delta wye connected transformers with KVA rating as required.
2. Transformers shall be suitable for indoor or outdoor installation as indicated on the plans, or as required by conditions. Transformers 75 KVA and less shall be suitable for floor, wall or trapeze mounting. Transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.
3. Transformer shall be enclosed in a steel enclosure with covers secured with captive type hardware. Transformer shall be cooled by natural convection of air. The transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with a gray baked on enamel.
4. The average audible sound level shall not exceed 50 DB for transformers rated at 75 KVA and below, nor 60 DB for transformers rated above 75 KVA, when measured in accordance with NEMA Standard TR1.
5. The percent impedance for transformers shall not exceed 4.6 for up to 112 1/2 KVA 6 for 150 KVA to 750 KVA.
6. The transformers shall have the following characteristics:
    a. Class H insulation
    b. 150-degree Centigrade temperature rise rating at 40 degrees C ambient at full rated load.
    c. Compartment for primary and secondary connections.

d. Transformer coils shall be of continuous copper wound construction with terminations brazed or welded. Coils shall be impregnated with non-hygroscopic, thermosetting varnish.

e. The maximum temperature of top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

f. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible copper grounding conductor sized in accordance with applicable NEMA, IEEE, or ANSI standards.

g. Transformers shall have two (2) 2-1/2% full ampacity taps below and two (2) 2-1/2% taps above rated voltage in primary.

h. The basic impulse level shall be 10 KV for transformers less than 30 KVA, 30 KV for transformers 300 KVA and larger.

i. Transformer primary and secondary windings shall be copper. Aluminum windings shall not be permitted.

j. Transformers shall have efficiencies in accordance with NEMA TP-1. Provide written documentation as part of submittal process stating this and showing actual transformer efficiencies.

7. Three-phase transformer efficiency, total losses, shall not exceed losses @ 35% and 75°C per the NEMA Premium program tested per 10 C.F.R. Part 431 ("Test Procedures for Distribution Transformers"). Shall not exceed

   a. 15 kVA: 97.88% 112.30 W; 121.28 W

   b. 30 kVA: 98.24% 185.52 W; 200.35 W

   c. 45 kVA: 98.38% 256.42 W; 276.93 W

   d. 75 kVA: 98.59% 362.89 W; 391.92 W

   e. 112.5 kVA: 98.73% 500.31 W; 540.33 W

   f. 150 kVA: 98.80% 576.14 W; 622.22 W

   g. 225 kVA: 98.95% 764.14 W; 825.26 W

   h. 300 kVA: 99.02% 1010.010 W; 1090.81 W.

3.00 EXECUTION

3.01 LOCATION

A. Electrical Contractor to verify proper location for the unit.

B. The transformer shall be installed in a location where the sides with ventilated openings are a minimum distance of six inches from noncombustible structures or equipment to ensure adequate air circulation

3.02 INSTALLATION

A. Set the transformer plumb and level. Provide solderless lug bonding connection on the inside of the transformer enclosure in accordance with the NEC. Make primary and secondary connections with liquid tight flexible metal conduit to isolate transformer noise from the building structure or conduit system.

B. When final connection has been made, check secondary voltage at dry transformers and make tap adjustments required to obtain correct voltage.

C. Perform the following isolation procedures in addition to those provided by the transformer Manufacturer. Provide pad-type vibration isolators or waffle pads sized to load 50 pounds per square inch. Install one (1) at each corner of the transformer at floor mount or trapeze installations. Locate pads between hanger and wall for wall hung installations

D. For critical installations, spring type isolation may be required by the Engineer consisting of steel, spring-type isolators, sized for 1/2" deflection based on the weight of the transformer. Install at each corner or in hanger rods so that vibration is not transmitted to the building structure.

E. Secure transformer to concrete base according to manufacturer's written instructions.

F. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

C. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

A. Inspect installed dry type transformers for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible mechanical and electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.

3.05 CLEANING

A. Repaint scratched or marred exterior surfaces to match original finish.

3.06 TESTING

A. Testing: All testing required shall be per Specification 26 01 26 Testing of Electrical Systems.

B. Transformers furnished to this specification shall receive the following production tests:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
2. Applied Potential;
3. Induced Potential;
4. No Load Losses;
5. Voltage Ratio;
6. Polarity;
7. Continuity

C. Manufacturer shall perform the following additional tests on units identical to the design type being supplied to this specification. Manufacturer shall provide on request test data sheets to prove performance of these tests.

1. Sound Levels
2. Temperature Rise Tests
3. Full-Load Losses
4. Regulation
5. Impedance

3.07 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION

26 24 13 600 VOLT SWITCHBOARDS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install a complete 600-volt switchboard. Electrical work shall be in accordance with Section 26 05 00 “Common Work Results for Electrical.”

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers: Products shall comply with the specifications and shall be by the following Manufacturers:

1. Square D
2. Eaton
3. No Approved Equal

B. The manufacturer shall provide the services of factory field engineers for startup, field tests, troubleshooting, Owner training and the supervision of storage and installation. The manufacturer field services shall include a minimum of the following:

1. Start up	1 day
2. Field Tests	1 day
3. Troubleshooting	1 day
4. Owner Training	1 day

5. These times do not include travel time and include a minimum of 8 working hours per day.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include shop drawings with the following minimum information:

A. Shop Drawings: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component related equipment.

1. Shop Drawings
    a. Any deviations from the specifications should be clearly identified on a separate sheet of paper in the shop drawing submittal.
    b. Complete rating
    c. Short circuit withstand ability of bus and lowest rated device
    d. Overall outline dimensions including the space available for conduit
    e. Conduit entry and exit points clearly showing dimensions of entry and exit points. Provide a detailed bottom view showing how conduits penetrate the bottom of the

switchboard. Coordinate with the Electrical Contractor on this prior to submitting information to the Engineer.

f. Overall weight of line-up and each shipping split

g. Complete bill of materials with cut sheets on all major equipment clearly identifying exact model numbers of each component.

h. Circuit schedule indicating the circuit number

i. Device description

j. One-Line diagram and Three-Line diagram to be submitted with initial submittal, No Exceptions.

k. Product Data Sheets for Switchboard, Automatic Load Transfer Controls, UPS, Meter, and Circuit Breakers, miscellaneous electrical equipment, etc.

l. Provide a drawing of the front view elevation with designation of equipment and devices on doors, and clearly indicating the maximum mounting height of devices on doors.

m. Project Specific Wiring Diagram: Detail wiring diagram and differentiate between manufacturer-installed and field-installed customer wiring. Show both power and control wiring. Show terminal strip information identifying all customer field terminations. Provide project specific wiring diagrams. Generic wiring diagrams are not acceptable.

n. Provide Project Specific Wiring Diagram for power meter clearly indicating where it is connected in relation to the circuit breaker and the sizes of the CT's, etc.

o. Description of transfer operating sequence, both automatic and manual.

p. Terminal strip layout showing customer field connections. The terminal strip layout shall also include a label next to each connection indicating signal description.

q. Bill of Material

r. Nameplate Schedule

s. Warranty Information

t. Main breaker ground fault test data per National Electrical Code requirements

u. UPS battery sizing calculations

v. Note: All documentation listed above shall be supplied with the Switchboard's initial submittal. Incomplete submittals will be returned "NOT APPROVED, REVISE AND RESUBMIT".

2. Field Test Data – Equipment Installation Report:

   a. Field test data shall include summary of all tests performed in the field specifically identified in this specification and other factory standard tests.

   b. Test ground fault systems on service entrance main breakers per NFPA 70. Document all tests and finish to Engineer as formal submittal.

3. NETA Acceptance Testing Specification (ATS) field tests and inspections tests report.

4. Supplier shall submit a training outline for Owner's/Engineer's review and comment a minimum of 4 weeks before training is to take place.
5. Operation & Maintenance Manual Data:
    a. Include all features and operating sequences, both automatic and manual. List all factory setting relay and provide relay-setting and calibration instructions, including software, where applicable.
    b. Operation and maintenance manuals shall contain the shop drawings, submittals, list of manufacturer recommended spare parts, schematics, equipment installation report, and maintenance procedures. O&M manuals shall include all field changes made during startup and testing.
    c. Operation and maintenance manuals shall include warranty information as well as a warranty information page that shall include information on the warranty start and end date as well as contact information for service.
    d. Manuals shall be prepared by the Equipment Manufacturer and shall also incorporate appropriate final certified shop drawings. Manuals may be manufacturer's standard instructions, but shall be supplemented as necessary to cover any special feature not included in standard material.
    e. Submit preliminary manuals for review prior to start-up of equipment.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.04 STANDARDS

A. The applicable provisions of the following standard shall apply as if written here in its entirety:

B. NEMA Std. PB-2 Deadfront Distribution Switchboards

C. NEMA Std. AB-1 Molded Case Circuit Breakers and Molded Case Switches

D. NEMA Std. KS-1 Enclosed Switches

E. U.L. 489 Molded Circuit Breakers

F. U.L. 891 Switchboards

G. U.L. 1008 Automatic Transfer Switches

H. NFPA 70 National Electrical Code

1.05 DELIVERY AND STORAGE

A. The manufacturer shall be responsible for delivery of the equipment, and accessories, f.o.b. to the job site or to such storage site as may be designated by the Owner or the Contractor, in good condition and undamaged.

B. Unloading and storage of the equipment shall be the responsibility of the Contractor who shall inspect the equipment the equipment for apparent damage. Equipment which is found to be damaged will not be accepted until properly repaired or replaced by the equipment manufacturer.

C. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

D. Equipment must be delivered and stored in accordance with the manufacturer's recommendation at all times. Equipment shall be stored indoors in a clean, dry, climate controlled heated and air conditioned environment that is free from dust, No Exceptions. Store equipment indoors in a dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances and physical damage.

E. 100 watt incandescent lamps shall be placed in the switchboard enclosure sections as required and energize to prevent the buildup of condensation during extended storage periods.

F. Deliver in sections or lengths that can be moved past obstructions in delivery path.

1.06 COORDINATION

A. Contractor shall coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Contractor shall coordinate sizes and locations of equipment bases with actual equipment provided. Cast anchor-bolt inserts into bases.

2.00 PRODUCTS

2.01 SWITCHBOARD

A. The switchboard shall be freestanding front access only and consist of the required number of vertical sections bolted together to form one (1) metal, enclosed, rigid switchboard. The switchboard shall conform to U.L. Standard #UL891 and NEMA Standard PB-2. The U.L. label shall appear on all switchboard sections which contain U.L. devices. The switchboard shall be U.L. listed for service entrance equipment.

B. Enclosure Type 1 General Purpose

1. Sections shall be completely front and rear aligned. Staggered arrangements are not acceptable.
2. The Switchboard shall be of dead-front construction and require front access only.
3. The switchboard frame shall be of formed steel rigidly bolted together to support all cover plates, bussings, and component devices during shipping and installation. The sides, top and rear shall be covered with single tool removable screw-on, code gauge, steel plates. Include all protective devices and equipment, including necessary interconnections.
4. Each switchboard enclosure shall have an open bottom and individually removable top plate for installation and termination of conduit.
5. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be ANSI 61 light gray or approved equal, applied by electro-deposition process over an iron phosphate pre-treatment.
6. Top and bottom conduit areas shall be clearly indicated on shop drawings.
7. The maximum dimensions for the switchboard shall be as indicated below, No Exceptions.

Equipment Name	Maximum Dimensions of Switchboard (no exceptions)
SWBD-1	100” W x 38” D x 92” H

8. Enclosure shall be bottom entry and bottom exit. See plans for additional information.

C. All feeder device line and load connection straps shall be rated to carry current rating of device frame.

D. The main incoming bus bars shall be rated for the protective frame size or main incoming conductors.

E. A tin-plated copper bus shall be of the amperage scheduled on the plans. Tin-plating shall be applied continuously to all bus work. Neutral shall be full capacity.

F. Bus bars shall be mounted on supports of high impact, non-tracking, insulation material which is braced to withstand mechanical forces exerted during 65,000 amp RMS symmetrical short circuit conditions.

G. Secure a tin-plated copper ground bus to each vertical section of the structure and extend it the entire length of the switchboard.

H. Bus arrangement shall be A-B-C type, left-to-right, top-to-bottom and front-to-rear. The switchboard, cables and bus connections shall be entirely accessible from the front, unless specifically indicated otherwise.

I. Furnish ground fault protection on each main device which is rated 1000 amps or larger. Device shall be a U.L. listed, ground sensor relay system equal to General Electric GSR. Provide ground break components for each system with coordinated ground sensor (CR) and integral test winding. A solid state relay shall operate the shunt trip circuit on the switch and monitor panel. Use a time relay-type relay with a continuously adjustable

current pick-up setting of 100 to 1200 amperes and continuously adjustable time delay setting from instantaneous (.03 seconds) to one (1) second. The relay shall also have a memory function which recognizes and initiates tripping on intermittent ground faults. Install a panel which indicates relay operations, provides a means for testing the system with or without the interruption of electrical service, and does not permit the ground fault system to be inadvertently left in an inactive or "off" state. Use a ground sensor for zero sequence arrangement on the main service entrance devices.

J. Power Meter displays, indication lights, switches, etc. shall be mounted no higher than 5'-6" AFF, which shall include the height of the 4" housekeeping pad. Front panel layout showing exact mounting heights shall be submitted to the Engineer for approval.

K. Incoming Main Sections and Feeder Devices

1. Main devices and feeder devices 800 amps and above shall be individually mounted circuit breakers (100% rated).
2. Feeder devices shall be group mounted molded case circuit breakers, unless noted otherwise.
3. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity: 65kA.
4. Series rated feeder devices shall not be acceptable.
5. All breakers shall be capable of being locked in the OFF position.

L. Molded Case Circuit Breakers

1. Molded case circuit breakers shall be provided with the following symmetrical current interrupting capacity: 65kA.
2. Group mounted breakers shall be connected to the vertical bus by bolted connection.
3. Individually mounted breakers shall be stationary mounted.
4. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an over center, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation.
5. Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.
6. Breakers larger than 150 amps shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating.

M. Main Breaker, Generator Breaker and Feeder Breakers 800 Amps and Above

1. Breakers shall be manually operated, fixed mounted, with the capability of being electrically operated.
2. Breakers shall have solid-state adjustable trip settings with Long time, Short time, Instantaneous and Ground settings (LSIG).
3. Breakers shall have trip indication of Overload, Short Circuit, and Ground Fault trip.

4. Breaker sections shall be suitable for terminating copper conductors using compression type lugs. See electrical one-line diagram for size and number of conductors required per phase for breakers.
5. Switchboard manufacturer shall coordinate with generator manufacturer on size of incoming breaker to provide.
6. The generator main breaker shall have shunt trip capabilities. The shunt trip circuit breaker shall have a response time not to exceed 50ms.
7. The manufacturer shall make accommodations in the main and generator incoming termination sections for the quantity and size of incoming conductors as indicated on contract drawings.

N. METERING

1. Metering device on main incoming breaker and generator breaker section shall be Multilin PQM II, Eaton PX4000 or approved equal. Meter shall have capability to communicate using Modbus TCP/IP Ethernet. Provide all hardware and software as required for Ethernet communications. Communication signals shall be wired out to terminal blocks that are readily accessible.
2. The metering device shall incorporate the following functions and features:
   a. The power meter shall measure and report the following quantities at a minimum:
      1). A, V, VA, W, var, KWH, KVARH, PF, Hz
      2). W, var, A VA Demand
      3). A, V, Unbalance
      4). Total Harmonic Distortion (THD) of each current and voltage
      5). Waveform Capture
      6). Data Logging
      7). Communications - Modbus TCP/IP Ethernet
   b. The power meter shall provide the following accuracies at a minimum:
      1). Power meter shall comply with ANSI C12.20.5 class for revenue meters.
      2). Phase Currents, Each Phase: ±0.05 percent.
      3). Phase-to-Phase Voltages, Three Phase: ±0.05 percent.
      4). Phase-to-Neutral Voltages, Three Phase: ±0.05 percent.
      5). Kilowatts: ±0.1 percent.
      6). Kilovars: ±0.1 percent.
      7). Power Factor: ±0.1 percent.
      8). Frequency: ±0.02 Hz.
      9). Accumulated Energy, Kilowatt Hours: ±0.1 percent; accumulated values unaffected by power outages up to 72 hours.
   c. The digital meter shall have the following user interfaces:

1). Integrated keypad/touch screen to access actual values and setpoints.

2). Relay output shall be through alarm, auxiliary and pulse output functions.

3). The meter shall provide a user configurable pulse output base on KWH, KVARH, or KVAH.

4). The meter shall provide a pulse input for demand synchronization.

5). The meter shall include a simulation mode capability for testing the functionality and meter response to programmed conditions without the need for external inputs.

O. INSTRUMENT CURRENT TRANSFORMERS: Capable of carrying continuously its rated primary amperes under conditions of accidental open secondary circuit without damage to the primary insulation. Burden capacity shall be adequate to supply the connected relays, meters and accessories.

P. INSTRUMENT POTENTIAL TRANSFORMERS: Substantial and well built, insulation meeting the requirements of the standards of ANSI. At normal ratings under usual service conditions, no part of the transformer shall exceed the heating limits specified in the standards of ANSI when serving its connected load. Where the Plans indicate a switchboard to have voltage metering, two (2) instrument potential transformers shall be furnished at the switchboard metering point.

Q. INDICATING LIGHTS, SWITCHES, PUSHBUTTONS: Heavy duty and oil tight (30 mm); Square D Class 9001 or approved equal. Pilot lights shall be push to test (LED type) and shall be Square D SK or approved equal.

Q. SURGE PROTECTION DEVICES

1. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition Type 2, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

   a. Fuses, rated at 200-kA interrupting capacity.

   b. Fabrication using bolted compression lugs for internal wiring.

   c. Redundant suppression circuits.

   d. Redundant replaceable modules.

   e. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

   f. LED indicator lights for power and protection status.

   g. Audible alarm, with silencing switch, to indicate when protection has failed.

   h. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation, No Exception. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

i. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 200kA per mode.

3. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

4. Protection modes and UL 1449 3rd edition VPR for grounded wye circuits with 480Y/277V, three-phase, four-wire circuits shall be as follows:

   a. Line to Neutral: 1200 V for 480Y/277V.

   b. Line to Ground: 1200 V for 480Y/277V.

   c. Neutral to Ground: 1200 V for 480Y/277V.

R. GRAPHIC USER INTERFACE TOUCH SCREEN

1. Touch screen shall be 15-inch LCD terminals with full touch screen capabilities as manufactured by GE. Each unit will be programmed as required to provide control displays to monitor and control the functions assigned to the PLC's. Automatic and local control interfaces shall be provided. Coordinate with Owner for exact information to be read on touch screen.

2. One copy of the manufacturers touch screen development software will be included under this specification. The license for the software shall be registered to the Owner.

3. Touch screen shall be mounted to the Switchboard at a maximum elevation of 5'-0" AFF, include the housekeeping pad in the mounting height.

4. The Contractor shall provide all programming and all required interconnection cables for a complete and operational system.

S. Provide switchboard with adequate lifting means, capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

T. Nameplates

1. Equipment nameplates and designations shall be 2 in. by 5 in. minimum, not less than 1/16 in. thick, engraved laminated plastic fastened with stainless steel screws. Nameplates shall be 1 in. white lettering on black background, and shall indicate equipment designations as shown on the drawings.

2. Provide legend plates or 1 in. by 3 in. engraved nameplates with ¼ in. lettering for identification of all pilot devices and meters. Legend nameplates shall be secured with stainless steel screws.

3. Provide permanent warning signs as follows:

   a. "DANGER – HIGH VOLTAGE – KEEP OUT" on all enclosure doors.

   b. "WARNING – HAZARD OF ELECTRIC SHOCK – DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT"

4. Provide arc flash labeling in accordance with the National Electrical Code Article 110 and per the Arc Flash Hazard Analysis (performed by others). See Section 26 05 73.01, "Electrical Power System Studies" for more information.

3.00 EXECUTION

3.01 INSTALLATION

A. Install the distribution switchboards on concrete foundations as indicated. Terminate service and feeder conduits only in the switchboard section containing the lugs or device to which they are to be connected.

3.02 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Test ground fault systems on service entrance main breakers per the National Electrical Code. Document all tests and furnish to Engineer as formal submittal.

3.03 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturer’s specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings according to Short Circuit and Relay Coordination Study and program power meter as required.

3.04 CLEANING

A. Touch up scratched or marred surfaces to match original finish. Provide one quart of touch-up paint.

3.05 WARRANTY

A. Manufacturer shall warrant equipment to be free of defects in materials and workmanship for eighteen (18) months from date of shipment.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.01, “Electrical Power System Studies”.

3.07 TRAINING

A. The Contractor shall provide a training session for the Owner’s representatives for 8 hours at the jobsite or other office location chosen by the Owner.

B. The training session shall be conducted by a manufacturer's qualified representative.

C. The training program shall consist of the following:

1. Review of the switchgear one-line drawings and schedules.
2. Review of the factory record shop drawings and placement of the various cells.
3. Review of each type of cell, components within, control, and power wiring.
4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
5. Provide three-ring binders to participants complete with copies of drawings and other course material covered.
6. Training shall include theory of operation, application and troubleshooting. A training outline and manual of training course material shall be provided to the Owner two weeks in advance of the course. Training shall be for four members of the Owner's staff. Training session shall be coordinated and scheduled with Owner.
7. All costs (travel expenses, testing equipment, etc.) required for the start-up, testing and training shall be the responsibility of the equipment manufacturer/contractor.

SUBMITTAL DATA SHEET FOR

26 24 13, 600 VOLT SWITCHBOARDS

Submit the following data with Bid Proposal and with Shop Drawing submittal:

Item No.	Description	600V Switchboard "SWB-1"
1	Manufacturer:	
2	Equipment Dimensions (inches): Length x Width x Height	
3	Total Weight (lbs.):	

END OF SECTION

26 24 16 PANELBOARDS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install lighting and branch panelboards. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

1.02 QUALITY ASSURANCE - ACCEPTABLE MANUFACTURERS

A. Panelboards shall comply with the specifications and shall be by the following Manufacturers:

1. Eaton
2. General Electric
3. Square D
4. No Approved Equal

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

1. Shop Drawings:
    a. Bill of Material
    b. Front Elevation with dimensions
    c. Assembly ratings including short circuit ratings, continuous current and voltage
    d. Cable terminal sizes
    e. Cut sheet on circuit breakers and surge protective devices

1.04 STANDARDS

A. Circuit breakers, molded case, and branch circuit shall be in accordance with the applicable provisions of the following standards as if written here in their entirety:

1. Fed. Spec. W-C-375
2. NEMA AB1 Molded Case Circuit Breakers and their application.
3. NEMA PB1 Panelboards

1.05 DELIVERY AND STORAGE

A. Equipment shall be handled and stored in accordance with the manufacturer’s instructions. Equipment shall be protected from damage.

1.06 WARRANTY

A. The manufacturer shall warrant the equipment to be free from defects.

1.07 QUALITY ASSURANCE

A. Manufacturer shall be ISO 9001 2000 or later certified.

B. Manufacturer shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

2.00 PRODUCTS

2.01 PANELBOARDS

A. Panelboards shall consist of a box, front, interior and circuit protective devices and shall be manufactured in accordance with NEMA PB1 and bearing the applicable U.L. labels.

B. Panelboards shall be four wire, three-phase as scheduled or required. Panelboards shall be NEMA 1 for air-conditioned spaces and 4X 304Stainless Steel for all other locations and suitable for surface mounting. Panelboards shall contain sequence style busing and full capacity neutral, composed of an assembly of bolt-on, molded case, automatic breakers with thermal and an instantaneous, magnetic trip in each pole and a trip-free position separate from either the "On" and the "Off" positions. Two (2) and three (3) pole circuit breakers shall simultaneously open all poles. The use of metal clips tying single pole circuit breakers together to make a multi-pole breaker shall not be allowed. Circuit breakers, molded case and branch circuits shall be in accordance with Fed. Spec. W-C-375.

C. The voltage rating, phase, number of wires and ampere rating shall be as indicated and scheduled on the plans.

D. The panelboard box shall be fabricated of code gauge, steel in accordance with U.L. standards and have turned edges around the front for rigidity and frontal clamping. Provide standard knockouts on the panel enclosures.

E. The panelboard front shall be fabricated of sheet steel and finished with a baked on gray enamel over a rust inhibitor. Each front shall have a door mounted on semi-concealed hinges with a cylinder lock, an index card and a card holder. Panelboard locks shall be master keyed, with two (2) keys furnished for each panelboard. Index cards shall be properly typewritten.

F. The interior of the panelboard shall consist of a factory-assembled, rigid frame supporting the rectangular bus, the mains and the neutral bar.

G. Busings shall be tin-plated copper and arranged for sequential phasing throughout. The bus bar shall be sized so that the temperature rise is limited in accordance with NEMA standards. The insulated neutral bar shall be located at the opposite end of the structure from the mains.

H. Panelboards shall have either solderless lugs or a main circuit protective device as scheduled. Each enclosure shall have grounding lugs and uninsulated equipment grounding terminals.

I. All circuit breakers shall be installed so that the center of the grip of the operating handle of the circuit breakers, when in its highest position, will not be more than 6”-0”. above the finished floor or working platform.

2.02 CIRCUIT BREAKERS

A. Panelboards shall be equipped with circuit breakers.

B. Circuit breakers shall be molded case, bolt in type.

C. Single pole circuit breakers serving fluorescent lighting loads shall have the SWD marking. Circuit breakers serving air conditioning branch loads shall be U.L. listed as type HACR.

D. Each circuit breaker used in the panelboards shall have an interrupting capacity of not less than the RMS symmetrical rating indicated on the plans for that panelboard.

E. Circuit breakers shall be manufactured by the panelboard manufacturer.

F. The panelboard and circuit breaker interrupting capacities and rating shall be equal to or greater than the fault currents available to each panelboard and as shown on the panelboard schedules on plans. Series rating of breakers shall not be permitted.

2.03 SURGE PROTECTION DEVICES

A. Surge Protection Device Description: IEEE C62.41-compliant, internally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition Type2, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch/circuit breaker.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit, transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Rating: 200kA per phase, 100kA per mode.

C. Protection modes and UL 1449 3rd edition VPR for grounded wye circuits with 480Y/277V, 208Y/120V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral, Line to Ground, Neutral to Ground: 1200 V for 480Y/277V and 800 V for 208Y/120V.
2. Line to Line: 2000 V for 480Y/277V and 1200 V for 208Y/120V.

3.00 EXECUTION

3.01 INSTALLATION

A. Install the panelboard in accordance with applicable codes at each location indicated on the plans. Provide filler plates for unused spaces in the panelboard. All labeling shall be in accordance to Section 26 05 00, “Common Work Results for Electrical” and Section 26 05 53 “Identification for Electrical Systems”.

B. Mount panelboard with 1/4” spacers off of walls.

C. Panelboard mounting height shall be coordinated with the equipment height such that the top of the panelboard shall not exceed 84” above finished floor.

D. NAMEPLATES:

1. For indoor applications with Air Conditioning: Plastic, white 1" letters on black background, on the front of each door on the switchgear; identifying the compartment contents for each compartment.
2. All other applications: Plastic, white 1" letters on black background, on the front of each door on the switchgear; identifying the compartment contents for each compartment.
3. Attach nameplates with a stainless-steel screw and nut at each end of the nameplate. Adhesive backed nameplates shall not be installed.

END OF SECTION

26 27 26 WIRING DEVICES

1.00 GENERAL

1.01 WORK INCLUDED

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. GFCI receptacles.
2. Toggle switches.

1.03 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

F. SPD: Surge protective device.

G. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

E. Spare parts

2.00 PRODUCTS

2.01 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.02 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles: Comply with UL 498 Supplement sd.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2.03 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Weatherproof switches: Fitted with single switch as specified, and weather proof cover with spring door cover; grey in color for all areas. Switch ratings shall be as identified below for the number of poles required.
2. Motor rated switches: HP rated switches approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4HP; 20 amp switches for loads exceeding 10A.
3. Single Pole:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1). Eaton (Arrow Hart).
      2). Hubbell Incorporated; Wiring Device-Kellems.
      3). Leviton Manufacturing Co., Inc.
      4). Pass & Seymour/Legrand (Pass & Seymour).

3.00 EXECUTION

3.01 INSTALLATION

A. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

B. Device Installation:

1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
2. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
3. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
4. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
5. Use a torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

C. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

D. Device Plates: Do not use oversized or extra-deep plates.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install disconnects. Electrical work shall be in accordance with Div. 26 specifications.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Molded-case switches.
5. Enclosures.

1.03 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.04 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and SKM PTW32 or ETAP electronic format.

B. Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and SKM PTW32 or ETAP electronic format.

F. Spares: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22deg F and not exceeding 104deg F.

2. Altitude: Not exceeding 6600feet.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

2.00 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.02 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Square D; by Schneider Electric.
3. GE.

B. Type HD, Heavy Duty:

1. Double throw.
2. six pole.
3. 600-V ac.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.03 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Square D; by Schneider Electric.
3. GE.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.04 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Square D; by Schneider Electric.
3. GE.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

O. Features and Accessories:

   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with ground-fault trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac.

2.05 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. Square D; by Schneider Electric.
   3. GE.

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:
   1. Standard frame sizes and number of poles.
   2. Lugs:
      a. Mechanical type, suitable for number, size, trip ratings, and conductor material.
      b. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.
   3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   5. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
   7. Alarm Switch: One NO contact that operates only when switch has tripped.
   8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
   9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
   10. Electrical Operator: Provide remote control for on, off, and reset operations.

11. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.06 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location

B. Enclosure Finish: The enclosure shall be finished with a brush finish on Type 316 stainless steel (NEMA 250 Type 4-4X stainless steel).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.02 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.03 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Outdoor Locations: NEMA 250, Type 4X, 316 stainless steel.
2. Other Wet or Damp, Indoor NEMA 250, Type 4X, 316 stainless steel.
3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 with cover attached by Type 316 stainless steel bolts.

3.04 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.05 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that the unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

e. Verify that fuse sizes and types match the Specifications and Drawings.

f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1). Use a low-resistance ohmmeter.

a). Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a). Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

i. Verify correct phase barrier installation.

j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that the unit is clean.

e. Operate the circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1). Use a low-resistance ohmmeter.

a). Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a). Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1). Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2). Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3). Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4). Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.01 "Electrical Power System Studies."

END OF SECTION

26 29 23.11 LOW VOLTAGE VARIABLE FREQUENCY DRIVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Design, manufacture, factory test, and deliver and install Variable Frequency Drives with bypass across-the-line starters as described herein and shown on the project drawings. The VFDs shall operate on 480 VAC, 3-phase, 60 Hz with harmonic filters, drive isolation transformers, and all appurtenances needed to meet the requirements of these specifications.

B. The VFDs shall be suitable to drive the pumping units over the range specified in specification 44 42 56.04 “Submersible Pumps”. The variable frequency drives shall be included in the Contractor’s scope of work.

C. VFDs shall comply with the latest applicable standards of ANSI, IEEE, NEMA, NEC, and UL. The controllers shall be rated as indicated. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.*

D. The manufacturer shall provide the services of factory field engineers for start up, field tests, troubleshooting, and the supervision of storage and installation. The manufacturer field services shall include a minimum of the following:

1.	Start up	3.0 days
2.	Field tests	3.0 days
3.	Troubleshooting	3.0 days
4.	Owner training	1.0 days

These times do not include travel time and include a minimum of 8 working hours per day.

E. The Contractor shall coordinate the design, testing and manufacturing of the drive with the motor supplier to provide a complete unit, free of detects and fully compatible with the pumping unit.

F. Perform Harmonic analysis. Test VFDs to verify harmonic analysis results.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

A. SHOP DRAWINGS

1. Drawings shall show equipment dimensions, stub-up locations, shipping splits, shipping weights, ventilation details and nameplate schedule.

2. Provide a drawing of the front view elevation with designation of equipment and devices on doors, and clearly indicating the maximum mounting height to the top of the devices on the door.

3. Project specific control schematics and wiring diagrams.

4. Terminal strip layout showing customer field connections. The terminal strip layout shall also include a label next to each connection.
5. Complete component Bill of Material with model numbers listed for individual components.
6. Breakdown description of the VFD model number indicating what options are being provided.
7. Catalog cut sheets of major components and power equipment.
8. Data sheets of miscellaneous electrical equipment clearly identifying exact model provided.
9. Data sheet of Motor Protection Relay clearly indicating what options are being provided.
10. Spare Parts List
11. Cable Terminal Sizes
12. Conduit Entry and Exit locations
13. True and Displacement power factor and efficiency.
14. Warranty Information
15. Letter of Compatibility: The VFD supplier in conjunction with the pump/motor supplier shall issue a letter of compatibility stating that the VFD and motor are compatible.
16. Harmonic distortion analysis: The manufacturer of the drive equipment shall perform a bus voltage and/or current distortion calculation for each bus that supplies a drive. The harmonic study shall be performed to determine the harmonic content expected on the Purchaser's supply bus due to the addition of the variable frequency drive and to determine the harmonic filter requirements. The total harmonic distortion shall not exceed THD values as recommended by IEEE - 519, 1992 under normal worst case operating conditions. The recommended harmonic filter shall be supplied by the drive manufacturer. Harmonic analysis shall be provided prior to or with the VFD shop drawings for approval. SUBMITTALS FOR THE VFD SUBMITTED PRIOR TO OR WITHOUT THE HARMONIC ANALYSIS SHALL BE CONSIDERED INCOMPLETE AND NOT REVIEWED.

B. FACTORY TEST DATA: Factory test data shall include a summary of all tests performed at the factory, both those specifically identified in this specification and other factory standard tests.

C. FIELD TEST DATA –EQUIPMENT INSTALLATION REPORT: Field test data shall include summary of all tests performed in the field specifically identified in this specification and other factory standard tests.

D. MANUFACTURER'S INSTRUCTIONS: Indicate installation procedures that ensure acceptable workmanship and installation standards shall be achieved.

E. OPERATION AND MAINTENANCE MANUALS:

1. Operation and maintenance manuals shall contain the shop drawings, submittals, schematics, final wiring diagrams with any changes made during start-up, equipment installation report and maintenance procedures.

2. Operation and maintenance manuals shall include warranty information as well as a warranty information page that shall include information on the warranty start and end date as well as contact information for service.

1.03 QUALITY ASSURANCE

A. ACCEPTABLE MANUFACTURERS

1. VFDs shall be:

a. Allen Bradley

b. Eaton

c. No other manufacturers shall be accepted

B. The VFD manufacturer shall demonstrate 5 years experience with the drives of the type and size herein specified.

C. Variable frequency drives shall be of sufficient size for the duty to be performed and shall not exceed their full rated capacity when the driven equipment is operating as specified.

D. The variable frequency drive manufacturer shall maintain, as part of a national network (United States), engineering service facilities within 50 miles of the project site to provide start-up service, emergency service calls, repair work, service contracts, and maintenance and training of customer personnel. When requested by the Engineer, documentation shall be provided showing compliance, capabilities, and references for this requirement.

E. All equipment shall be NEMA rated. IEC or dual rated IEC/NEMA shall not be acceptable.

F. Complete VFD integrated line-up shall be U.L. listed.

G. The VFD manufacturer shall be responsible for coordinating with the pump motor manufacturer to meet the design and performance requirements of the specification. The VFDs shall be installed by the Construction Contractor.

H. FACTORY INSPECTION AND TESTS

1. GENERAL

a. Equipment furnished under these specifications shall be subject to inspection during manufacture by a representative of the Owner who shall be afforded proper facilities for determining compliance with the specifications.

2. The VFD manufacturer shall provide the following quality assurance steps within his factory:

a. Incoming inspection of all components.

b. In-process inspection of assemblies.

c. 100% test and inspection of power devices.

3. The VFD printed circuit boards shall be tested per the manufacturer's standard testing procedure. The VFD manufacturer shall provide certification that the tests have been completed.

4. Manufacturer Standard Tests

5. The VFD manufacturer shall submit to the Engineer for approval the factory test report including providing the actual test data, observations and certification that the tests have been completed prior to the VFD being released for shipment. The factory tests shall provide information with site conditions (temperature), temperature inside top of VFD during different loads; 100%, 85%, and 75% after steady state of each. During this test, the efficiency of the VFDs shall be measured by simultaneously measuring the total KW input of the VFDs and the KW output of the VFD. The factory test report shall also include information on the wattmeter instruments used during the tests.

I. FIELD QUALITY CONTROL: The manufacturer shall furnish an equipment test report after installation, start-up and testing.

1.04 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. Local Laws and Ordinances.

B. State and Federal Laws.

C. National Electrical Code (NEC).

D. Underwriters' Laboratories (U.L.)

E. American National Standards Institute (ANSI).

F. National Electrical Manufacturers Association (NEMA).

G. Institute of Electrical and Electronics Engineers (IEEE).

1.05 DELIVERY AND STORAGE

A. The VFD manufacturer shall be responsible for delivery of the equipment and accessories, freight on board to the job site or to such storage site as may be designated by the Owner or Installation Contractor in good condition and undamaged.

B. Unloading and storage of the equipment shall be the responsibility of the Installation Contractor who shall inspect the equipment for apparent damage. Equipment which is found to be damaged will not be accepted until properly repaired or replaced by the VFD manufacturer.

C. Store materials according to manufacturer's instructions. Equipment shall be stored indoors. Provide 100 Watt incandescent bulb or space heater inside each compartment of the VFD and energize upon delivery.

1.06 WARRANTY

A. All equipment furnished under this section shall be warranted by the Supplier for a period of three (3) years after Final Acceptance, including all parts, labor, travel and all related expenses. Final acceptance shall be understood to mean 100 hours of trouble free operation of all VFDs without a single failure or problem with the equipment, and operating per the specifications.

B. The Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

C. Upon receipt of notice from the Owner's representative of failure of any part of the systems or equipment during the warranty period, the Contractor, shall replace the affected part or parts within three (3) working days, at no cost to the Owner.

D. The Contractor shall furnish a written guarantee covering the above requirements before the final payment is made.

1.07 HARMONIC ANALYSIS

A. Provide an electrical system harmonics analysis for the electrical distribution system including the electric utility. The goal of the study shall be to determine requirements for the variable frequency drives and isolation/phase shifting transformers to comply with the harmonic distortion levels.

B. The harmonics analysis shall verify compliance with the harmonics and line notching requirements specified herein. The location of the point of common coupling shall be defined as the main bus of the 480 Volt Switchboard. The study shall evaluate all VFDs operating at the lowest operating speed as specified in the pump specification, all VFDs operating at the full speed condition, and ten percent speed increments between these points. The study shall contain, as a minimum, the following:

1. Preliminary harmonic levels without VFDs installed.
2. Preliminary harmonic levels with the VFDs operating.
3. Preliminary harmonic levels with the VFDs operating and the Switchboard ATO switched to normal Utility power.
4. Preliminary harmonic level with the VFDs operating and the Switchboard ATO switched to Generator power.
5. Explanation of method used to perform the study.
6. Explanation of study results.
7. All calculations and/or computer printouts used to arrive at the recommendations.
8. Voltage and Current harmonic content up to the fiftieth harmonic, for the conditions specified above.

C. The harmonic distortion for voltage and current distortion levels and line notching shall meet the requirements of IEEE 519, latest version without the need for any ancillary filtering equipment.

D. The Manufacturer/Contractor shall be responsible to obtain all data necessary to perform the study. This includes feeder cable sizes, approximate feeder length, motor data, switchgear data, electric utility data, and any other information relevant to the study. The analysis shall use actual system impedance, Utility transformer impedance, and available fault current from the Utility.

1. The voltage harmonic distortion (THD) at the point of common coupling shall not exceed 5% as indicated in Table 10.2 of IEEE Std. 519, latest version, for General System.

2. The current harmonic distortion at the point of common coupling shall not exceed the limits in Table 10.3 of IEEE Std. 519, latest version, for General Distribution Systems.

3. Compliance shall be verified by manufacturer or manufacturer's representative with onsite field measurements of both the voltage and current harmonic distortion at the defined point of common coupling with and without the VFDs operating.

E. If harmonic filters are required to meet the requirements of the IEEE 519, the VFD manufacturer must provide the filters, and is responsible for the design and manufacturer of the filters at no cost to the Owner.

F. The report shall be provided prior to or with the variable frequency drive shop drawings for approval. Submittals for the variable frequency drives submitted prior to or without the study will be considered incomplete and not reviewed.

G. Compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the defined point of common coupling with and without the VFDs operating.

H. VFD manufacturer shall coordinate with the local Utility, Oncor Electric Delivery, Contact: Jordan Reed (Email: Jordan.Reed@oncor.com) for electrical data required for the harmonic analysis.

2.00 PRODUCTS

2.01 GENERAL

A. Any modifications to a standard product required to meet this specification shall be performed by the VFD manufacturer only.

B. Drive shall be air cooled. Liquid cooled systems shall not be acceptable. The VFD shall consist of an incoming main circuit breaker section with an AIC rating of 65,000, input rectifier grade drive isolation transformer, input converter/DC bus/output inverter and control logic section. All components shall be integral to the VFD lineup, factory wired and tested as a complete system.

C. VFD system shall maintain a .95 minimum true power factor from 30% to 100% speed. VFD system include power factor correction and/or harmonic filter shall never have a leading power factor under utility or generator operation. VFD manufacturer is to supply a power factor correction system, if required, to meet this requirement. Power factor correction system shall include a separate input isolating contractor with fuses, power factor correction grade capacitors and series harmonic decoupling reactors, all mounted and wired as part of the drive system. Power factor correction system shall be mounted in the VFD.

D. SEQUENCE OF OPERATIONS

1. Refer to the Contract Drawings for control schematic and Section 40 90 03 "Control Narratives" for additional information.

2.02 18-PULSE VARIABLE FREQUENCY DRIVES

A. RATINGS

1. Guaranteed minimum VFD efficiency shall be 96.5% at 100% speed and 100% load and minimum 95% at 80% speed. Losses shall include drive isolation transformer, input

harmonic filters and power factor correction system, if applicable, converter/DC bus/Inverter, and output harmonic filter. Auxiliary control, such as internal VFD control boards, cooling fans or pumps, shall be included in all loss calculations.

2. Rated Input Power: Non-phase sequence sensitive, 380-480 Volts, +/–10%, 3-phase, 60 Hz.
    a. Voltage Dip Ride-through: VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
    b. Power Loss Ride-through: VFD shall be capable of 5 cycle power loss ride-through without fault activation.
    c. All 120VAC power for VFD control logic and cooling fans or pumps shall be fused and supplied by the integral to the VFD.
3. Output Power: 400HP, 480V, 6 to 60 HZ, 1800 RPM Maximum Speed
    a. VFD manufacturer shall coordinate with pump and motor manufacturers for exact motor requirements: HP, amps, RPM, etc. VFD and pump/motor manufacturers shall provide a letter stating that the VFD and motor are compatible.
4. Ambient Temperature Range: 0 to 40°C.
5. Humidity: 95% non-condensing.
6. Elevation: Up to 3300 feet (1000 meters) above MSL without derating.
7. Power Unit Rating Basis: 100% rated current continuous, 150% rated current for one minute, at rated temperature.

B. CONSTRUCTION

1. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a re-load of any drive parameters or configurations. The controller shall be suitable for any standard NEMA-B squirrel-cage induction motor having a service factor of 1.15. The inverter output shall be generated by IGBT's. The VFD shall not create excessive power losses in the motor.

C. BASIC FEATURES

1. The VFD shall be capable of producing an adjustable AC voltage/frequency output to provide continuous operation over the normal system 30%-100% speed range. The VFD must be capable of sustained operation at 1/10 speed to facilitate checkout and maintenance of the driven equipment.
2. The door of each unit shall include the door mounted components as shown on the VFD control schematic. Operator interface and control logic shall be 120VAC. All control and signal wires shall be shielded and fully protected against EMI/RFI interference.
3. The VFD shall include a customer selectable automatic restart feature. When enabled, the VFD shall automatically attempt to restart after a trip condition resulting from overcurrent, overvoltage, under voltage, or overtemperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a customer programmable time period. Auto-Restart shall be programmable to allow for individual fault selection.

If required to provide this function, the VFD manufacturer must supply and mount within the VFD a separate programmable logic controller to provide this feature.

4. A door-mounted keypad as provided by the manufacturer as their standard interface with shall be furnished, capable of controlling the VFD and setting drive parameters. The keypad shall include the following features:

   a. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.

   b. The keypad module shall contain a "self-test" software program which can be activated to verify proper keypad operations.

   c. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting (rather than codes). Driver parameters shall be factory set in EEPROM and resettable in the field through the keypad. Six (6) levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

   d. The following door mounted digital indications shall be supplied:

      1). Speed demand in percent
      2). Input current in amperes
      3). Output current in amperes
      4). Output Frequency in hertz
      5). Input voltage
      6). Output voltage
      7). Total 3-phase KW
      8). Kilowatt hour meter
      9). Elapsed time running meter (electro mechanical)
      10). Output speed in percent.

   e. The following door mounted pushbuttons, control switches and indicating lights shall be supplied:

      1). Emergency Stop pushbutton (push/pull type)
      2). Hand-Off-SCADA selector switch
      3). Start Pushbutton
      4). Stop Pushbutton
      5). White indicating light (Power On)
      6). Amber push-to-test indicating light (EST Low Level Lockout)
      7). Amber push-to-test indicating light (Discharge Pressure Loss)
      8). Red push-to-test indicating light (Pump Run)
      9). Green push-to-test indicating light (Pump Stop)
      10). Amber push-to-test indicating light (VFD Fault)
      11). Amber push-to-test indicating light (RTD Trip)

   f. VFD shall be capable of direct communication to an IBM or compatible computer for serial link setup of parameters, fault diagnostics, trending and diagnostic log downloading. A USB port shall be door-mounted for computer interface.

g. Printed circuit boards shall be conformal coated.

D. ENCLOSURE: All VFD components including transformer shall be mounted and wired by the VFD manufacturer in a grounded enclosure meeting the following requirements without exception:

1. Power conversion and auxiliary equipment enclosure sections shall be NEMA-1 design.
2. All relays, pushbuttons, etc. shall be housed in a separate 20" auxiliary equipment enclosure that shall be a part of the VFD enclosure.
3. Maximum dimensions for VFD enclosure, including transformer, shall be 100" H x 124" W x 36" D.
4. VFD shall be top entry for incoming conductors and conduit and top exit for outgoing conductors and conduits. Incoming conductors and conduit shall as indicated on contract drawings.
5. Printed circuit boards shall be conformal coated.
6. All power conductors (bus or cable) shall be insulated.
7. All relays and pushbuttons shall be NEMA rated, heavy duty type. IEC or dual IEC/NEMA rated equipment shall not be acceptable.
8. All wiring shall be located internally within the VFD enclosure. External ductwork or wireways shall not be utilized.
9. Terminal blocks shall be NEMA rated, 600V. Stacking (two-high) terminal blocks is not acceptable.
10. All wiring shall be identified with wiring markers with alphanumeric characters. The identification of each wire shall be the same as that shown on the electrical schematic. Each wire shall be so identified at each end. Each end of every wire shall be provided with a heat shrinkable or equivalent sleeve-type wire marker-labeled in accordance with the electrical schematic. Use of adhesive and clip-on type markers is prohibited.
11. INSTRUMENT CURRENT TRANSFORMERS: Each instrument current transformer shall be indoor wound type, meter class. Insulation shall be equal to that necessary to meet the requirements of the IEEE standards. At normal rated amperes, under usual service conditions, no part of the transformer shall exceed the heating limits specified in the IEEE standards. Each current transformer shall be capable of carrying continuously, its rated primary amperes, under conditions of accidental open secondary circuit, without damage to the primary insulation. Accuracy shall have ANSI accuracy classification C400.
12. CONTROL RELAYS: Industrial type; contacts rated for 10 amps at 600 VAC; Allen-Bradley Bulletin 700 Type PK, Square D Class 8501 Type X, or approved equal. Relays shall have the capability of having contact decks added in the field. Contacts shall be field convertible to normally open or normally closed. Coils and contacts shall each be replaceable without replacing any other part of the relay. Where control relays are indicated on the Plans, industrial control relays shall be furnished whether the relay coil is operated with 120 VAC or 24 VDC.
13. TIMING RELAYS: Solid state. Ranges shall be as shown on the Plans. The timing relays shall have both normally open and normally closed contacts by having two sets of form

C contacts. Timing relays where shown on the Plans shall be Square D, Class 9050 Type JCK60, or Allen-Bradley Type 700-HRM time delay relay, or approved equal model for operation on the control voltage of the equipment it is used in. Timing relay shall be provided with restraining strap.

14. INDICATING LIGHTS, SWITCHES, PUSHBUTTONS: Heavy duty and oil tight (30 mm); Square D Class 9001 or approved equal. Pilot lights shall be push to test (Cluster LED type) and shall be Square D SK or approved equal.
15. ELAPSED TIME METER: The meter shall be of a non-reset type, for totalizing of hours and shall operate on 120 VAC, 60 Hertz. Starter shall be provided with an elapsed time meter; Simpson Model 1357ET Wide-Vue type elapsed time meter, or approval equal. Digital time meters are not acceptable.
16. Maximum door swing clearance shall not exceed 36".
17. After fabrication, metal structures shall be thoroughly cleaned, bonderized as a unit and then given a primary coat, a coat of rust preventative and a finishing coat of quick-drying lacquer. Unless otherwise specified, the color of the panels and the exteriors of structures shall be gray ANSI-61. Instruments, relays, and meters shall have dull black standard finish.
18. Air shall be exhausted through the top and front of the VFD enclosure. No air shall be exhausted through the rear of the enclosure.
19. The control relays, timing relays, terminal strips shall be readily accessible while the VFD is energized and operating without exposing a person to live 480V when the VFD door is open. For this purpose provide a 20” wide (minimum) full vertical section for controls only, no exceptions.
20. Provide a print pocket pouch with the control schematic drawings on the inside of the VFD door. The control schematic drawings shall be the final version of the drawings and shall include any field revisions made during start-up.
21. Lights, pushbuttons, switches, displays, motor protection relay, etc. shall be mounted no higher than 5’-0” AFF. Front drive panel layout showing exact mounting heights shall be submitted to the Engineer for approval.
22. VFD manufacturer shall verify with motor manufacturer that the contact from the VFD for energizing the motor space heater is properly sized to handle the space heater load.

E. NAMEPLATES

1. Externally visible, permanent nameplates shall be provided to identify each instrument, switch, indicating light, etc. Equipment and terminal blocks shall be suitably identified. This shall include items on the back side of doors and panel mounted items. Nameplates shall be black with white lettering and attached with stainless steel screws.
2. Equipment nameplates and designations shall be 2 in. by 5 in. minimum, not less than 1/16 in. thick, engraved laminated plastic fastened with stainless steel screws. Nameplates shall be 1 in. white lettering on black background, and shall indicate equipment designations as shown on the drawings.

3. Provide legend plates or 1 in. by 3 in. engraved nameplates with ¼ in. lettering for identification of all pilot devices and meters. Legend nameplates shall be secured with stainless steel screws.
4. Provide permanent warning signs as follows:
    a. "DANGER – HIGH VOLTAGE – KEEP OUT" on all enclosure doors.
    b. "WARNING – HAZARD OF ELECTRIC SHOCK – DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT"
    c. Provide arc flash labeling in accordance with the National Electrical Code Article 110.16 and per the Arc Flash Hazard Analysis (performed by other). See Specification 26 05 73.01 "Power System Studies" for more information.

F. PROTECTIVE FEATURES AND CIRCUITS
1. The VFD controller shall include the following alarms and protective devices:
2. Static instantaneous overcurrent and overvoltage trip.
3. Power loss protection.
4. Power unit over-temperature alarm and protection. Upon sensing an over-temperature condition VFD is to annunciate an alarm and automatically reduce output speed in order to shed load maintaining process operation. If over-temperature continues beyond specified period, unit to trip on over-temperature.
5. Electronic motor inverse time overload protection.
6. The VFD shall be protected from damage due to the following, without requiring an output contractor:
    a. Single-phase fault or three-phase short circuit on VFD output terminals.
    b. Failure to communicate inverter thyristor due to severe overload or other conditions.
    c. Loss of input power due to opening of VFD input disconnect device or utility power failure during VFD operation.
    d. Loss of one (1) phase of input power.
    e. Motor regeneration due to backspin or loss of VFD input power.
7. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components.
    a. Failure to connect a motor to the VFD output.
    b. VFD output open circuit that may occur during operation.
8. The VFD shall have auto frequency roll-back capability during overload or overtemperature and conditions to minimize nuisance tripping.

G. Control functions such as start, stop, alarm, and status functions shall be transmitted as discrete I/O to the station PLC (provided by others). The VFD shall be capable of communicating setup parameters for 4 diagnostics, trending information, and diagnostic log downloading using Modbus TCP/IP Ethernet to the station PLC.

H. All I/O, discrete, analog and Ethernet signals shall be wired to terminal blocks and labeled for customer's use.

I. PARAMETER SETTINGS

1. The following system configuring settings shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only. Except for Motor Nameplate Data, all parameters must be adjustable while the processor is on-line and the drive is running.

a. Motor Nameplate Data

1). Motor frequency
2). Number of poles
3). Full load speed
4). Motor volts
5). Motor full load amps
6). Motor KW
7). Current limit, max.

b. VFD Limits

1). Manual accel rate
2). Manual decel rate
3). Auto accel rate
4). Auto decel rate
5). Motor flux buildup delay: time/amount
6). I boost
7). Overload trip curve select (Inverse or Constant)
8). Min/Max speed (frequency)
9). Auto reset for load or voltage trip select
10). Overload trip time set

c. Motor Monitor Data

1). Motor stator alarm and trip temperatures
2). Motor bearing and alarm and trip temperatures
3). Motor stator and cable entry leak alarm

d. VFD Parameters

1). Voltage loop gain
2). Controller Adjustments
3). PID control enable/disable
4). Setpoint select
5). Proportional band select
6). Reset time select
7). Rate time select
8). Input signal scaling
9). Input signal select (4-20 mA/0-5 Volts)
10). Auto start functions: On/Off, Delay On/Off,
Level Select On/Off

11). Speed Profile: Entry, Exit, Point Select
12). Min, Max Speed Select
13). Inverse Profile Select
14). Critical speed avoidance select

2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via fiber optic as well as on the keypad display.

J. DIAGNOSTIC FEATURES AND FAULT HANDLING

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source responsibility, availability of service and access to spare parts).
2. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 10 most recent events (minimum):
    a. VFD mode (HAND-OFF-AUTO)
    b. Date and time of day
    c. Type of fault
    d. Reset mode (Auto/Manual)
3. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 M/Sec. intervals for the 50 intervals immediately preceding a fault trip:
    a. VFD mode (LOCAL-OFF-REMOTE)
    b. Speed demand
    c. VFD output frequency
    d. Demand (output) Amps
    e. Feedback (motor) Amps
    f. VFD output volts
    g. Type of fault
    h. REMOTE enable

3.00 EXECUTION

3.01 GENERAL

A. The Manufacturer's Representative has responsibilities in the installation and field testing of the equipment as described in this Section. Installation of equipment shall be performed by the Construction Contractor who shall be required to assemble the equipment, if required, and install it in accordance with Installation, Operation and Maintenance instructions which shall be furnished by the vendor or manufacturer, and the installation drawings for this project.

1. The Construction Contractor shall furnish all labor, tools, equipment and machinery necessary to receive, inspect, unload, store, protect, and install completely, in proper operating condition, the equipment. Contractor shall protect and store the VFD indoors, as recommended by the manufacturer and as described in section 1.05.

2. He shall also furnish such incidental items not supplied with the equipment, but which may or may not be described in the Plans and Specifications, for complete installation, such as wiring, conduit, ducts, anchors and other appurtenances as necessary.

B. The Contractor shall schedule the service of the manufacturer to assist in the installation, adjustment, and acceptance test of the equipment

3.02 INSTALLATION AND START-UP

A. Manufacturer's representative shall be available to advise and assist the installation of the VFDs by others.

B. Furnish the services of a competent manufacturer's service representative who shall be experienced in the assembly and wiring of the VFD drive units of similar size and character. He shall direct the installation of the equipment and shall assist and advise with the electricians or other workmen who are performing the actual work of installing the VFD drive units. He also shall assist in the adjustment and testing of the equipment.

C. Adjust the calibration of protective relays according to the relay coordination study (provided by others) and test the settings. Prepare a card index for the relays, the settings, the test results and marked thereon, and submit to the Owner.

D. Instruct the operating and maintenance personnel in principle of operating of all major devices and the care and maintenance of components included in the VFD drive units, for a period of not less than one (1) eight (8) hour day.

E. Time spent on the job by the service representative shall be adequate for performing the above functions.

F. All costs (travel expenses, testing equipment, etc.) required for testing start-up, and training shall be the responsibility of the equipment manufacturer/Contractor.

3.03 TRAINING

A. The Contractor shall provide a training session for the Owner's representatives at the jobsite or other office location chosen by the Owner. Each eight hour training session shall be broken up into two segments each of 4-hours with a 15 minute break every two hours. Lunch break will be one hour. Training sessions shall be scheduled and coordinated with the Owner.

B. When requested within the equipment warranty period, provide an additional training session from that indicated above for the Owner's Representative at the jobsite or other office location chosen by the Owner. Each eight hour training session shall be broken up into two segments each of 4-hours with a 15 minute break every two hours. Lunch break will be one hour. Training sessions shall be scheduled and coordinated with the Owner.

C. Training sessions shall be conducted by VFD manufacturer personnel.

D. Training shall be for four members of the Owner's staff.

E. Supplier shall submit a training outline and manual of training course material for Owner's/Engineer's review and comment a minimum of 4 weeks before training is to take place.

F. Instruct the operating and maintenance personnel in principle of operating of all major devices and the care and maintenance of components included in the VFD drive units, and troubleshooting for a period of not less than one (1) eight (8) hour day. Coordinate with Owner for exact requirements. Provide three-ring binders to participants complete with copies of drawings and other course material covered.

G. All costs (travel expenses, testing equipment, etc.) required for the training shall be the responsibility of the equipment manufacturer/contractor.

3.04 FIELD QUALITY CONTROL

A. Testing, checkout and start-up of the VFD equipment shall be performed under the technical direction of the manufacturer's field service Engineer from the Factory of the VFD manufacturer. Under no circumstances are any portions of the drive system to be energized without authorization from the field service Engineer.

B. Once the drive has been installed, testing shall be provided by the manufacturer to verify conformance with the specifications for the following:

1. Harmonics
2. Efficiency
3. True Power Factor

Note: Tests are to be conducted on normal utility power and stand-by generator power. The harmonics, efficiency and power factor tests shall be measured at the input to each drive and point of common coupling and data shall be taken at the different operating speeds (50%-100% speed in 5% increments). Readings with printouts shall be provided for the harmonics, efficiency and true power factor in the report to be submitted to the Engineer.

C. The type of instruments' make, model and manufacturer that are used in the field testing shall be submitted along with the report.

D. A description of the testing procedures shall be sent to the Engineer prior to testing taking place.

E. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

F. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following. Perform the following field tests and inspections and prepare test reports.

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment (including pretesting and adjusting of solid-state controllers).
3. Report results in writing.
4. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

G. The VFD Supplier shall provide readings with printouts of the harmonic current at each harmonic as well as the total voltage distortion up to the 50^{th} harmonic. The following readings shall be provided:

1. At point of common coupling:
    a. With all drives running with load at the different operating speeds (50%-100% speed in 5% increments).
    b. With all drives off
2. At the power connection to each drive:
    a. With the drive running loaded at the different operating speeds (50%-100% speed in 5% increments).
    b. With drive off
3. All the above data including the efficiency and power factor data, complete with meter reading and recordings, where applicable, shall be submitted to the Engineer in a written report format for review and approval by the Engineer. If these tests show that the drives are not in compliance with the Specifications, the drive manufacturer shall make all changes required to comply with the Specifications at no cost to the Owner. If required, this could mean replacing the drives that are not in compliance.

H. The tests shall be witnessed by the Owner and Engineer. Provide at least two (2) weeks notice to the Owner and Engineer prior to conducting these tests. Final acceptance of the VFD installation will not be considered until the Owner and Engineer have witnessed the test described above and a formal written report has been submitted and approved by the Engineer. The report shall be submitted within two (2) weeks after start-up.

I. The VFD manufacturer’s factory field service Engineer shall submit a written Equipment Installation Report certifying the equipment is properly installed and has been operated under all operating conditions and is operating under all operating conditions and is operating satisfactorily per the requirements of the specification.

J. Provide for the Engineer's review a complete list of test procedures, standards, equipment and calibration reports of the measuring and testing equipment used.

K. Any deficiencies with regard to these specifications shall be corrected by the manufacturer at no expense to the Owner. Prior to any corrective action, a plan of correction shall be submitted to the Engineer for approval.

L. During start-up the VFD manufacturer's representative shall coordinate with the motor supplier for the optimum carrier frequency to operate the VFD at to keep the audible noise of the motor to a minimum. The VFD manufacturer shall also take into account dv/dt to reduce the stresses imposed on the motor windings and efficiency of the drive.

M. For Final O&M manual, the Manufacturer shall provide a hard copy of the final VFD set points be provided and revised control schematics including any changes to control schematic made during start up.

3.05 SPARE PARTS

A. The following spare parts of the type and size furnished shall be provided:

1. Ten of each type of power and control fuse rated 600V or less.
2. Five of each type of panel lamp.
3. One spare relay and timer of each type.
4. One of each type of printed circuit board, including diagnostic systems.
5. One microprocessor-based interface display and monitoring panel, and keypad.
6. One of each fan or blower installed.

3.06 CLEAN AND ADJUST

A. The manufacturer shall furnish sufficient touch-up paint of the same type and color used at the factory to repair damages incurred in installation. Perform touch up painting to achieve the original paint thickness, quality, and appearance.

END OF SECTION

26 32 13 ENGINE GENERATORS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

B. Relevant Specification Sections:

1. Section 26 24 13 “600 Volt Switchboards”.

2. Section 26 29 13.11 “Low Voltage Variable Frequency Drives”.

C. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Battery charger.

2. Sub-base fuel tank.

3. Standby engine generator set.

4. Muffler.

5. Outdoor enclosure.

6. Starting battery

7. Fuel Maintenance system

8. Generator Set Controller and Panel.

D. The engine manufacturer’s authorized distributor shall supply the complete power system to include the generator and related components specified in this section, so that there is one source of responsibility for coordination and testing.

E. Equipment that shall be provided by the generator manufacturer that is further specified in other sections of these documents is as follows:

1. Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables”

2. Section 26 05 23 “Control Voltage Electrical Power Cables”

3. Section 26 05 26 “Grounding and Bonding for Electrical Systems”

4. Section 26 05 33 “Raceways and Boxes for Electrical Systems”

5. Section 26 24 16 “Panelboards”

6. Section 26 27 26 “Wiring Devices”

1.02 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

C. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

D. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

A. Pre-and Post-Submittal Meeting

1. Supplier shall include in his bid the cost of attending a one-day pre-submittal meeting and a one-day post-submittal meeting in the City of Grand Prairie offices – exact location to be determined at a later date. A pre-submittal meeting shall be held before any shop drawings are submitted. A post-submittal meeting shall be held after the Engineer’s shop drawing review comments have been submitted. Vendor shall determine the exact number of people attending the meeting per the specification requirements and cover each person’s cost.

2. Any shop drawings submitted before the pre-submittal meeting will be rejected and sent back Not Approved, Revise and Re-submit. The Generator Supplier shall bring with them a detailed list of the items their submittal will include for review by the Engineer or a draft copy of the actual submittal.

3. As a minimum the following shall attend the meeting:

a. General Contractor,

b. Electrical Contractor,

c. Generator Supplier and Engineer. Representatives from the Generator Supplier shall include:

d. The Project Manager who will be responsible for putting together the submittal and who will be responsible for the project at the factory, no exceptions.

e. The Project Engineer at the factory who has technical knowledge of the equipment, no exceptions.

f. A sales person may attend, but not as a substitute for the Project Manager and/or Project Engineer.

B. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

4. Wiring Diagrams: Power, signal, and control wiring.

5. Generator sizing analysis.

a. Detailed sizing analysis shall clearly identify assumptions made for loads being started/operated by the generator.

1). The maximum voltage drop allowed shall be 20%.

2). The generator shall be sized as follows:

a). The generator shall be sized to start and run three (3) 400HP 18-pulse VFD driven pump and motor and all other connected ancillary loads/equipment. Manufacturer shall certify that the generator will not stall under these conditions.

3). Ambient temperature shall be a minimum of 122 degrees Fahrenheit.

4). Calculations shall be for a Diesel Fuel generator set.

b. The generator manufacturer and Contractor shall be responsible for obtaining all information to run the generator sizing analysis, including nameplate rating listed on the motors. The manufacturer/Contractor shall be responsible for obtaining actual load data.

c. The kW rating shown on the plans is anticipated, but shall not be used to determine the actual size of the generator provided for this project.

6. Provide a detailed layout of the generator enclosure that shows the location of the medium voltage terminal box, generator control panel, lights, receptacles, panelboard, etc.

7. Provide cut sheets for all equipment being provided for the generator including but not limited to:

   a. Generator and Enclosure

   b. Panelboard

   c. Exhaust Fans and louvers

   d. Conduits

   e. Wiring

   f. Lights

   g. Switches

   h. Receptacles

   i. Batteries and charging system

   j. Fuel Maintenance System

   k. Starters, disconnects, pushbutton, etc.

   l. Provide a detailed panelboard schedule for the panelboard provided in the generator enclosure.

8. Certified summary of prototype-unit test report.

9. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

10. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

11. Report of sound generation.

12. Report of exhaust emissions showing compliance with applicable regulations.

D. Field quality-control test reports. Indicate and interpret test results and inspection records relative to compliance with performance requirements. Provide load bank and 3rd Party Sound testing results. All Generator Testing Report(s) shall be submitted to Engineer for approval no later than two weeks after testing has been conducted.

E. Equipment installation report.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 110 requirements

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable Federal, State and Local government requirements.

K. Comply with UL 1008

L. Comply with ATS Standard.

M. Comply with NEMA MG-1 and SG-1

1.05 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 50 deg C.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1000 feet.

1.06 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

1.08 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1. In accordance with OCA 252:565-7-4(b)(1), post a complete set of operational instructions, emergency procedures and maintenance schedules at the station.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Generator manufacturers:

1. Caterpillar; Engine Div.

2. Onan/Cummins Power Generation; Industrial Business Group

3. No approved equal

B. Acceptable Enclosure Manufacturer:

1. ACS

2. 3PI

3. E&CA

4. No approved equal

2.02 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: minimum of 1250kW but generator manufacturer shall verify rating based on loads identified below.

2. Output Connections: 480Y/277V, three-phase, four wire.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 33 percent variation for 100 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 11 percent variation for 100 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Loads and steps:

1. Generator manufacturer shall provide a detailed sizing analysis to the Engineer for approval. Detailed sizing analysis shall clearly identify assumptions made for loads being started/operated by the generator. When conducting the generator sizing analysis the voltage drop of the generator shall be set at a maximum of 20% and the maximum frequency dip shall be 10%. The nominal load on the generator shall not exceed 85% of the rated load capacity. The generator manufacturer and Contractor shall be responsible for obtaining all information to run the generator sizing analysis. Any changes to the generator size shall be brought to the Engineer's attention. Sizing analysis shall be submitted to the Engineer with the generator's initial submittal. Ambient Temperature: Minus 15 to plus 40 deg C.

2. Step 1

a. Panel LP – Misc. Loads

b. Wall Packs – WP-1, WP-2, WP-3, WP-4

3. Step 2

    a. Pump RWP-201 – 400HP Variable Frequency Drive driven motor.

4. Step 3

    a. Pump RWP-202 – 400HP Variable Frequency Drive driven motor.

5. Step 4

    a. Pump RWP-203 – 400HP Variable Frequency Drive driven motor.

2.03 ENGINE

A. Comply with NFPA 37

B. Fuel: Fuel oil, Grade DF-2.

C. Rated Engine Speed: 1800 rpm.

D. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements and comply with the sound level specified for sound attenuation enclosure.

G. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24V electric, with negative ground.

1. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

2. Cranking Cycle: As required by NFPA 110 for system level specified.

3. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.

4. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35A minimum continuous rating.

6. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 4X 316 stainless steel, wall-mounted cabinet.

g. Charger shall operate on 120V.

2.04 ENGINE COOLING SYSTEM

A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pump.

B. Radiator: Rated for specified coolant.

C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent distilled water, with anticorrosion additives as recommended by engine manufacturer.

D. Expansion Tank: Constructed of welded steel plate and equipped with gage glass and petcock.

E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

1. Rating: 50-psig (345-kPa) maximum working pressure with 180 deg F (82 deg C) coolant, and non-collapsible under vacuum.

2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

3. The generator shall be rated for continuous standby duty with a temperature rise of 125 deg C

2.05 GOVERNOR

A. The engine governor shall be an electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from no load to full rated load. Steady state frequency regulation shall be +/- 0.25%. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.06 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 2085 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: Usable Fuel for 120 hours' continuous operation at 80 percent rated power output.

3. Spill containment fill box, hinged, lockable design.

4. Low level alarm switch wired to generator control panel.

5. Leak sensor switch installed in interstitial space and wired to generator control panel.

6. Mechanical fill limiter with tight fill connection that shuts off the flow of fuel at a maximum of 95% of the tank name plate capacity.

7. High level alarm station at the tank fill location the alarms at 90% and 95% of tank capacity.

8. Containment Provisions: U.L. Listed double wall.

9. Emergency pressure relief vent

10. Normal vent extended above roof of enclosure with updraft vent.

11. Low fuel alarm with a spare dry contact.

12. Electrical stub-up, rectangular type, located directly beneath the generator terminal box, beneath the generator control panel and beneath the generator house power panel.

2.07 ENGINE EXHAUST SYSTEM

A. Muffler: Sized as recommended by engine manufacturer. Silencer(s) shall comply with the package sound attenuation level specified in Outdoor Generator Set Enclosure herein.

B. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.

C. Generator mufflers shall be mounted inside the enclosure to reduce noise pollution. The manufacturer shall provide isolate vibration for the muffler in the enclosure and shall reduce heat build-up inside the enclosure and provide quality support.

2.08 STARTING SYSTEM

A. Description: 24V electric, dual starters, with negative ground and including the following items:

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" paragraph in "Service Conditions" article above.

2. Cranking Cycle: As required by NFPA 110 for system level specified.

3. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above to provide specified cranking cycle at least three times without recharging. Battery size shall be BCI Group No. 8D minimum, and shall be rated not less than 220 amp hours. Necessary cables and clamps shall be provided. Engines equipped with dual starting motors shall have dual battery banks.

4. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 45A minimum continuous rating.

6. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 1236 and includes the following features:

    a. Operation: Equalizing-charging rate of 20A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.

    b. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

    c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.

    d. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.

    e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either condition closes contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

    f. Enclosure and Mounting: NEMA 250, Type 4X 316 Stainless Steel, wall-mounted cabinet.

    g. Charger shall operate on 120V.

2.09 CONTROL AND MONITORING

A. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.

B. Environmental: The generator set control shall be tested and certified to the following environmental conditions:

1. –40°C to +70°C Operating Range
2. 95% humidity non-condensing, 30°C to 60°C
3. IP22 protection
4. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
5. Sinusoidal vibration 4.3G's RMS, 24-1000Hz
6. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
7. Shock: withstand 15G

C. Functional Requirements: The following functionality shall be integral to the control panel:

1. The control shall include a minimum 64 x 240 pixel, 28mm x 100mm, white backlight graphical display with text based alarm/event descriptions
2. The control shall include a minimum of 3-line data display
3. Audible horn for alarm and shutdown with horn silence switch
4. Standard ISO labeling
5. Multiple language capability
6. Remote start/stop control
7. Local run/off/auto control integral to system microprocessor
8. Cooldown timer
9. Speed adjust
10. Lamp test
11. Push button emergency stop button
12. Voltage adjust
13. Voltage regulator V/Hz slope - adjustable
14. Password protected system programming

D. Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units:

1. Engine

    a. Engine oil pressure

    b. Engine oil temperature

    c. Engine coolant temperature

    d. Engine RPM

    e. Battery volts

    f. Engine hours

    g. Engine crank attempt counter

    h. Engine successful start counter

    i. Service maintenance interval

    j. Real time clock

2. Generator

    a. Generator AC volts (Line to Line, Line to Neutral and Average)

    b. Generator AC current (Avg and Per Phase)

    c. Generator AC Frequency

    d. Generator kW (Total and Per Phase)

    e. Generator kVA (Total and Per Phase)

    f. Generator kVAR (Total and Per Phase)

    g. Power Factor (Avg and Per Phase)

    h. Total kW-hr

    i. Total kVAR-hr

    j. % kW

    k. % kVA

    l. % kVAR

3. Voltage Regulation

    a. Excitation voltage

    b. Excitation current

E. Alarms and Shutdowns: The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

1. Engine Alarm/Shutdown

    a. Low oil pressure alarm/shutdown

    b. High coolant temperature alarm/shutdown

    c. Loss of coolant shutdown

    d. Overspeed shutdown

    e. Overcrank shutdown

    f. Emergency stop depressed shutdown

    g. Low coolant temperature alarm

    h. Low battery voltage alarm

    i. High battery voltage alarm

    j. Control switch not in auto position alarm

    k. Battery charger failure alarm

2. Generator Alarm/Shutdown

    a. Generator over voltage

    b. Generator under voltage

    c. Generator over frequency

    d. Generator under frequency

    e. Generator reverse power

    f. Generator overcurrent

3. Voltage Regulator Alarm/Shutdown

    a. Loss of excitation alarm/shutdown

    b. Instantaneous over excitation alarm/shutdown

    c. Time over excitation alarm/shutdown

    d. Rotating diode failure

    e. Loss of sensing

    f. Loss of PMG

F. Inputs and Outputs

1. Digital Inputs: The Controller shall include the ability to accept six (6) to eighteen (18) programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

2. Digital Outputs: The control shall include the ability to operate six (6) programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (10) Form C (Normally Open & Normally Closed) contacts.

3. Discrete Outputs: The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.

G. Maintenance: All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control

1. Engine running hours display

2. Service maintenance interval (running hours or calendar days)

3. Engine crank attempt counter

4. Engine successful starts counter

5. 20 events are stored in control panel memory

H. Remote Communications

1. The control shall include Modbus TCP/IP Ethernet communication. The remote communications shall also be capable of communicating Modbus TCP/IP Ethernet.

2. Remote Monitoring Software: The control shall provide Monitoring Software with the following functionality:

    a. Provide access to all date and events on generator set communications network

    b. Provide remote control capability for the generator set

    c. Ability to natively communicate using Modbus TCP/IP Ethernet.

3. Remote Indication: Provide a remote indication to SCADA.

    a. Provide the following individual digital outputs for the following indications for protection and diagnostics

        1). Low oil pressure warning

        2). Low coolant level

        3). EPS supplying load

        4). Battery charger AC failure

        5). Emergency stop

        6). Low Fuel Level

        7). Spare

        8). Spare

    b. The following additional metering shall be provided via Modbus TCP/IP via Ethernet for each Engine:

        1). Generator kW, kVA, kVAR, PF, Volts, Amps and frequency

        2). Generator AC Amperes – Phase A, Phase B and Phase C

        3). Generator AC Voltage – Phase A-B, Phase B-C, Phase C-A, Phase A, Phase B and Phase C (verify phase rotation)

        4). Engine RPM Meter

        5). Engine Battery Voltage Meter

        6). Engine Oil Pressure Gauge

        7). Engine Coolant Temperature Gauge

        8). Engine Running Hour Meter

9). Engine Start Counter

10). Atmospheric Pressure

11). Boost Pressure

12). Air Filter Restriction

13). Left Turbo Inlet Pressure

14). Right Turbo Inlet Pressure

15). Engine Hour meter

16). Total Fuel Burned

17). Engine Coolant Level Status

18). Local Engine Control Switch Position

19). Overspeed Switch Status

20). Remote Emergency Stop Actuated

21). Percent Engine Load

22). Oil Filter Pressure Differential

23). Fuel Filter Pressure Differential

24). Aftercoolant Temperature

25). Right Exhaust Temperature

26). Left Exhaust Temperature

27). Crankcase Air Pressure

28). Filtered Fuel Pressure

29). Right Air Filter Restriction

30). Left Air Filter Restriction

31). Fuel Consumption Rate

32). Engine Oil Temperature.

2.10 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker:

1. Molded-case, thermal-magnetic type; 100 percent rated for breakers below 800A; complying with NEMA AB 1 and UL 489.

2. Main devices and feeder devices 800 amps and above shall be individually mounted circuit breakers (100% rated)

3. Breakers shall have solid-state adjustable trip settings with Long time, Short time, Instantaneous and Ground settings (LSIG)

4. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity: 65kA.

5. Series rated feeder devices shall not be acceptable.

6. Breakers shall have trip indication of Overload, Short Circuit, and Ground Fault trip.

B. All breakers shall be capable of being locked in the OFF position.

C. Tripping Characteristic: Designed specifically for generator protection.

D. Trip Rating: Matched to generator rating.

E. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

F. Mounting: Adjacent to or integrated with control and monitoring panel

2.11 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H. Temperature rise of rotor and stator shall be limited to a maximum 125 degree C in 40 degree C ambient.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.12 OUTDOOR GENERATOR-SET ENCLOSURE

A. Provide a walk-in type weatherproof sound attenuated enclosure. Enclosure shall be constructed of pre-painted white formed aluminum panels. The enclosure shall be sized to adequately house the generator set and all accessories. Enclosure shall be designed for a minimum wind load rating of 100 mph (160 km/h). Provide wind load calculations and certification from an independent licensed professional engineer at time of submittal. Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure. All hinges, door locks, door handles, etc. shall be stainless steel.

B. Enclosure: Sound attenuation enclosure rated for 65dB @ 10 meters.

C. Description: Vandal-resistant, sound attenuating, weatherproof aluminum housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

D. Description: Prefabricated or pre-engineered walk-in factory assembled enclosure with the following features:

1. Construction: Aluminum, metal-clad, integral structural-aluminum-framed building erected on concrete foundation.

2. Space Heater: Thermostatically controlled and sized to prevent condensation.

3. Louvers: Equipped with bird screen arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.

4. Hinged Doors: With padlocking provisions or keyed latches.

5. Ventilation: Louvers equipped with bird screen arranged to permit air circulation while excluding exterior, birds, and rodents.

6. Muffler Location: Generator mufflers shall be mounted inside the enclosure to reduce noise pollution. The manufacturer shall provide isolate vibration for the muffler in the enclosure and shall reduce heat build-up inside the enclosure and provide quality support.

7. Walls shall be constructed of marine grade 0.080 minimum formed aluminum panels. Roof shall be constructed of marine grade mill finish 0.125 minimum thickness formed aluminum panels using an interlocking standing seam design capable of supporting 75 pounds per square foot. All external attaching hardware shall be stainless steel screw type mechanical fasteners. Enclosure shall be equipped with 4 point lifting means to remove the enclosure from the tank.

8. Provide a minimum of two entrance doors on each side. Doors shall be strategically located to provide easy access and serviceability. One door shall be located directly in front of the generator terminal box. Another door shall be located directly in front of the generator control panel. Door handles shall be two-point pad lockable type. Provide drip rails above each door opening. Provide intrusion detection on each door. Intrusion detection shall be accomplished via Hermetically sealed brushed anodized aluminum housing, Rhodium plated switch contacts, industrial wide gap magnetic contacts, UL listed, surface mount, 3' stainless steel armored cable, Sentrol 2500 series. Provide with one normally open and one normally closed set of contact. The intrusion switches shall be wired in series such that if any doors is opened, an alarm signal is sent to SCADA. Provide a 24VDC power supply in a NEMA 4X 304 stainless steel enclosure next to the door contacts.

9. Intake air shall enter the enclosure through an acoustic baffle section or hood located in the rear wall of the enclosure and shall include aluminum bird screen. Air intake shall be 1250 feet per minute of less to minimize water intrusion. The radiator discharge air shall pass through a horizontal discharge plenum section, which incorporates a motorized damper and aluminum bird screen. The air handling system shall be engineered and constructed so as not to exceed a total of 0.50 inches of water gauge static pressure drop with minimal water intrusion.

10. Engine Cooling Airflow through Enclosure: Adequate to maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

11. Enclosure shall dampen noise to 65 dBA within 10 meters of enclosure. The manufacturer shall be responsible for visiting the site prior to bid to determine the exact field conditions and exact property line distance from the generators. The manufacturer shall have 3rd Party testing performed in the field on the equipment after installation to confirm values are met. If it does not meet the most stringent requirements herein, it is the manufacturer's responsibility to make any changes necessary to meet the values specified at no additional cost to the Owner.

12. The manufacturer shall provide a minimum of two (2) duplex receptacles in the enclosure.

13. The manufacturer shall provide a minimum of four (4) LED light fixtures that shall be switched. The switch for the light fixture shall be located near each main door for the generator unit. The light fixture shall be located such that the light illuminates the control panel in the generator. The light fixture shall be Holophane catalog number EMX-

L48-7000LM-FGFL-MD-MVOLT-GZ10-40K-80CRI-DGXD, no equals. The manufacturer shall be responsible for all controls and wiring as required for a complete and operational system.

14. The manufacturer shall provide a minimum of two (2) LED light fixtures, one exterior light mounted in the center of the main exit door on each side of the generator enclosure. The exterior lights shall be controlled via a photocell and the controls shall be equipped with an On/Off/Auto selector switch to allow for manual or automatic operation of the exterior lights. The light fixture shall be Lithonia Lighting catalog number DSXW1-LED-10C-700-30K-T3M-MVOLT-DNAXD, no equals. The manufacturer shall be responsible for all controls and wiring as required for a complete and operational system.

15. Turn duct: Supply discharge air turn duct to direct sound and air upward. Provide sound dampening material on the turn duct to reduce noise.

16. GROUNDING MEANS: Provide two NEMA 2-hole ground pads located near the base of the generator mounted 180° apart. Ground pads shall be stainless steel and suitable for terminating #4/0 ground conductor.

E. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at with ambient temperature at top of range specified in system service conditions.

2.13 SERVICE PLATFORMS

A. Description: An OSHA approved service platform shall be provided on each side of the enclosure. Platform shall be designed so that all doors can open approximately 180 degrees and the platform shall extend the full length of the generator enclosure with access stairs on each end of each platform. Construction shall consist of A-36 structural frame members, stairs on one end, and hand rails. Walk area shall have surface grating, with safety treads, shall consist of 1” x 1/8” type 19-W-4 hot dipped galvanized steel, which shall be fastened to the frame with galvanize steel clips and plated bolts.

B. Finish: Platform surfaces shall be cleaned, primed and painted with two coats of epoxy and two coats of polane polyurethane.

C. Platforms shall ship for field assembly. The configuration shall be as shown on the contract plans. Platforms shall be anchored to the foundation with ½” adhesive anchors with a minimum of 4 ½” embedment.

2.14 VIBRATION ISOLATION DEVICES

1. Supply vibration isolators as recommended by the manufacturer.

2.15 FINISHES

A. Indoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

B. Outdoor Enclosure: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer. Color: Coordinate with the Owner.

2.16 FUEL MAINTENANCE SYSTEM

A. Each fuel storage tank shall include two stage fuel maintenance system that will remove dirt and water. The maintenance system shall be plumbed into the tank per the manufacturer's recommendations.

B. The separator shall remove 99.9% of the water in the fuel line and 95% of the solids.

C. The stabilizer shall decontaminate and stabilize the fuel without the use of chemical additives.

D. The system shall operate on 120V, 1 phase, 60Hz, 20A circuit breaker.

E. Programmable controller:

1. The controller shall be a UL 508 listed assembly.

2. Provide dry contact for general alarms.

F. The system shall be capable of treating the maximum amount of fuel that the entire subbase tank fuel system is capable of being filled with. Acceptable manufacturer is Fuel Technologies International LLC product number FTI-2.8.

G. The fuel tank shall be provided with all the necessary and required pipe and fittings for installation and proper operation of the system

2.17 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. 4 Hour full load

3. Maximum power.

4. Voltage regulation.

5. Transient and steady-state governing.

6. Single-step load pickup.

7. Safety shutdown.

8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

9. Report factory test results within 10 days of completion of test.

2.18 DISTRIBUTION

A. Provide 208Y/120V three phase, 4 wire, panelboard inside enclosure for distributing power to generator block heater, battery charger, lights, receptacles and any other devices requiring 208Y/120V power. Panelboard shall be minimum 30 pole with 60-amp main breaker, in a NEMA 3R 304 stainless steel enclosure, have bolt-on breakers with a minimum 42,000 AIC rating and tin-plated copper bus. Panelboards shall comply with Specification Section 26 24 16 “Panelboards” and shall be manufactured by Square D, Eaton, General Electric or Siemens.

B. Generator manufacturer shall be responsible for providing panelboard, Surge Protection Device (SPD), circuit breakers and all associated cabling and conduits to devices requiring power in the generator and the generator enclosure. Cabling shall be per Specification 26 05 19 “Low Voltage Electrical Power Conductors and Cables”, 26 05 23 “Control Voltage Electrical Power Cables” and conduit shall be per Specification 26 05 33 “Raceways and Boxes for Electrical Systems”.

C. The Manufacturer shall provide the minimum number and ampacity of circuit breakers as follows:

1. One 20A/1P Circuit Breaker for Interior Lights

2. One 20A/1P Circuit Breaker for Exterior Lights

3. One 20A/1P Circuit Breaker for Receptacles

4. One 20A/1P Circuit Breaker for Battery Charger

5. One 20A/1P Circuit Breaker for Generator Control Panel

6. One 20A/1P Circuit Breaker for Fuel Maintenance System

7. One Circuit Breaker sized as required for each block heater.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONCRETE BASES

A. Coordinate sizes and locations of concrete bases. Verify structural requirements with structural engineer.

B. Install concrete bases of dimensions indicated for packaged engine generators

3.03 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 26 Sections. Proceed with equipment startup only after wiring installation is satisfactory.

E. The contractor shall provide all fuel for testing of the generator. The contractor shall be responsible for providing a full tank of fuel upon completion of this project.

3.04 CONNECTIONS

A. Ground Equipment

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B

3.05 FIELD QUALITY CONTROL

A. Manufacturer’s representative shall be available to advise and assist the installation of the generators by the Construction Contractor.

B. Furnish the services of a competent manufacturer’s service representative who shall be experienced in the assembly and wiring of the generator units of similar size and character. He shall direct the installation of the equipment and shall assist and advise with the electricians or other workmen who are performing the actual work of installing the generator units. He also shall assist in the adjustment and testing of the equipment.

C. Startup procedures, testing and troubleshooting of the generator shall be performed under the supervision of the manufacturer's representative. Energization of the generators shall not be permitted without the manufacturer's representative permission

D. Time spent on the job by the service representative shall be adequate for performing all functions described herein.

E. All costs (travel expenses, testing equipment, etc.) required for testing start-up, and training shall be the responsibility of the equipment manufacturer/Contractor

F. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing. Provide on site field service for start-up.

G. Testing: Perform field quality-control testing under the supervision of the manufacturer's factory-authorized service representative.

H. Tests: Include the following:

1. Tests recommended by manufacturer, including under load tests. The engine distributor shall furnish all equipment and personnel required for testing, including load banks, transformer and cable.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

a. Single-step full-load pickup test.

b. 4-hour reactive load bank test.

3. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

7. Perform a reactive load bank test of each generator set at full load and 0.80 power factor for 4 hours at full load. Record system data at 15 minute intervals as recommended by the engine manufacturer.

8. Perform a system load bank test with the generator connected to the 480V main-tie-main Switchboard and operating at full load for 4 hours at 0.80 power factor.

9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within

10. Perform a load test with actual designed connected loads at the site with the generator connected to the 480V main-tie-main Switchboard and operating at designed load for 4 hours at 0.80 power factor.

11. The Contractor shall provide fuel for the testing and any subsequent re-testing of the generator and shall top off the fuel tank upon final completion.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. All Generator Testing Report(s) shall be submitted to Engineer for approval no later than two weeks after testing has been conducted.

L. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making

positive observation of test results. Make calibration records available for examination on request.

M. Contractor shall fill fuel tank with manufacturers recommended fuel when all tests have been completed.

3.06 COMMISSIONING

A. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

3.07 CLEANING

A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.08 TRAINING

A. All costs (travel expenses, testing equipment, etc.) required for testing start-up, and training shall be the responsibility of the equipment manufacturer/Contractor.

B. Training shall include theory of operation, application and trouble shooting. A training outline and manual of training course material shall be provided to the Owner two weeks in advance of the course. Each eight hour training session shall be broken up into two segments each of 4-hours with a 15 minute break every two hours. Lunch break will be one hour. Training session shall be conducted by Generator manufacturer personnel. Training session shall be scheduled and coordinated with the Owner.

C. Instruct the operating and maintenance personnel in principle of operating of all major devices and the care and maintenance of components included in the generator units, for a period of not less than one (1) eight (8) hour day. The one-day training shall take place at the Owner’s main office in Grand Prairie, Texas. Coordinate with Owner for exact requirements and dates for training.

D. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators as specified below:

1. Coordinate this training with the 600V Switchboard training.

2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

3. Review data in maintenance manuals. Review data in maintenance manuals.

4. Schedule training with Owner, with at least seven days advance notice.

5. Minimum Instruction Period: Eight hours.

6. Training shall not take place until construction is complete and generator online and fully operational.

E. When requested within the equipment warranty period, provide an additional training session from that indicated above for the Owner's Representative at the jobsite or other office location chosen by the Owner. Each eight hour training session shall be broken up into two segments each of 4-hours with a 15 minute break every two hours. Lunch break will be one hour. Training sessions shall be scheduled and coordinated with the Owner.

F. All costs (travel expenses, testing equipment, etc.) required for the start-up, testing and training shall be the responsibility of the equipment manufacturer.

3.09 WARRANTY

A. Manufacturer shall warrant equipment to be free of defects in materials and workmanship for twenty-four (24) months from date of shipment. The warranty shall including all parts, and labor

3.10 SERVICE CONTRACT

A. The Manufacturer shall provide an extended service agreement for two (2) years including all parts, labor, maintenance, testing, etc.

END OF SECTION

26 36 00 TRANSFER SWITCHES

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Contract Agreement and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less, including the following:

1. Bypass/isolation switches.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.

2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.

2. Include material lists for each switch specified.

3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.05 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

2.00 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. ATS shall have a withstand and close-on rating (WCR) of .05 seconds (or 3 cycles).

F. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

G. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

H. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

I. Neutral Terminal: Solid and fully rated unless otherwise indicated.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed shrinkable sleeve markers at terminations.

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

4. Accessible via front access.

K. Enclosures: NEMA 4X, 316 stainless steel**,** complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.02 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Acceptable Manufacturers:

1. ASCO 7000 series.

2. Eaton.

3. No others approved.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.

4. Conductor Connectors: Suitable for use with conductor material and sizes.

5. Material: Hard-drawn tinned copper, 98 percent conductivity.

6. Main and Neutral Lugs: Mechanical type.

7. Ground Lugs and Bus-Configured Terminators: Mechanical type.

8. Ground bar.

9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and for alternative normal-source voltage sensing. Adjustable from zero to six seconds, and factory set for one second.

2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

3. Fully automatic break-before-make operation with center off position.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

F. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to Alternate Source. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for

pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Alternate Power Supervision: Red light with nameplate engraved "Alternate Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

3.00 EXECUTION

3.01 INSTALLATION

A. Mount to equipment rack with 316 stainless steel hardware.
    1. Provide workspace and clearances required by NFPA 70.
B. Set field-adjustable intervals and delays, relays, and riser clock.
C. Comply with NECA 1.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to Alternate Source, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
B. Wiring Method: Install cables in raceways except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
D. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

E. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections**:**

1. After installing equipment, test for compliance with requirements according to NETA .

2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and required clearances.

d. Verify that the unit is clean.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

f. Verify that manual transfer warnings are attached and visible.

g. Verify tightness of all control connections.

h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.

j. Verify positive mechanical interlocking between normal and alternate sources.

k. Perform visual and mechanical inspection of surge arresters.

l. Inspect control power transformers.

1). Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2). Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

3). Verify correct functioning of disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.

b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.

c. Verify settings and operation of control devices.

d. Calibrate and set all relays and timers.

e. Verify phase rotation, phasing, and synchronized operation.

f. Perform automatic transfer tests.

g. Verify correct operation and timing of the following functions:

1). Normal source voltage-sensing and frequency-sensing relays.

2). Alternative source voltage-sensing and frequency-sensing relays.

3). Time delay on transfer.

4). Automatic transfer operation.

5). Interlocks and limit switch function.

6). Time delay and retransfer on normal power restoration.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.

b. Verify time-delay settings.

c. Verify pickup and dropout voltages by data readout or inspection of control settings.

d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

e. Verify proper sequence and correct timing of transfer time delay, retransfer time delay on restoration of normal power.

f. Verify grounding connections and locations and ratings of sensors.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

END OF SECTION

26 41 13 LIGHTNING PROTECTION FOR STRUCTURES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, design, materials, equipment and incidentals necessary to install a complete lightning protection system for the Collier's Ferry Raw Water Pump Station in accordance with UL 96A, NFPA 780. Lightning protection system shall be tied to the grounding system for the Collier's Ferry Raw Water Pump Station.

1.02 QUALITY ASSURANCE

A. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. Listing of the manufacturer in the lightning protection section of the current edition of Underwriters' Laboratories, Inc., Electrical Construction Materials List will be accepted as compliance with this requirement.

B. All materials shall be copper and bronze and of the size, weight and construction to suit the application where used in accordance with UL, NFPA, NEC code requirements for this type structure and as per manufacturer's recommendations. Class I sized components may be utilized on roof levels 75 feet and below in height. Class II sized components are required for roof levels over 75 feet in height.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, "Document Management", and shall include:

1. Shop Drawings
    a. Specifications
    b. Catalog Sheets for All Products Provided
    c. Shop drawings showing type, size and location of all equipment, grounds, cable routings, details, etc.
2. Continuity Test Report
3. Copy of U.L. Master Label for the Facility

1.04 STANDARDS AND REFERENCES

A. Refer to Section 26 05 00, "Common Work Results for Electrical", for all standards which apply to this section.

NFPA 780	Standard for the Installation of Lightning Protection Systems
UL 96A	Standard for Installation Requirements for Lightning Protection Systems
LPI 175	Lightning Protection Institute Standard of Practice

2.00 PRODUCTS

2.01 MATERIALS

A. Materials used in connection with the installation of the lightning protection systems shall be approved for lightning protection systems by the Underwriters' Laboratories, Inc. No combination of materials shall be used that form an electrolytic couple of such a nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. When unusual conditions exist which would cause deterioration or corrosion of conductors, conductors with suitable protective coatings or oversize conductors shall be used. If a mechanical hazard is involved, the conductor size shall be increased to compensate therefore, or suitable protection shall be provided. The conductors may be protected by covering them with molding or tubing preferably made of wood or nonmagnetic material. If metal tubing is used, the conductor shall be electrically connected to it at its upper and lower ends.

B. All equipment used shall be new and of a design and construction to suit the application in accordance with UL 96A requirements and shall be so marked.

2.02 MANUFACTURED PRODUCTS

A. CONDUCTORS - Copper conductors manufactured of copper grade ordinarily required for commercial electrical work generally designated as being 98 percent conductive when annealed. Down conductors of copper cable for installations other than towers shall weigh not less than 187.5 pounds per thousand feet and the size of any wire of this cable shall not be less than No. 17 AWG (0.045 inch). Down conductors shall be tinned. The thickness of any copper ribbon or strip shall be not less than No. 16 AWG (0.051 inch).

B. AIR TERMINALS - Air terminals shall be tapered to a blunt point. The rod shall be of solid copper, 1/2 inch in diameter. Air terminals and support shall be designed over 24 inches to handle a 75 pound per square foot wind load. All air terminals shall be supported by a suitable brace, with guide(s) not less than one-half the height of the air terminal. Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A. Air terminals shall extend at least ten inches above the object or area they are intended to protect. Air terminals shall be placed around the perimeter of flat or gently sloping roofs at intervals not exceeding 20 feet.

C. FASTENERS - Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Galvanized or plated materials shall not be used.

D. FITTINGS - Fittings/bonding devices, cable splicers, and miscellaneous connectors shall be suitable for use with the installed conductor and shall be copper, bronze or aluminum with bolt pressure connections to the cable. Cast or stamped crimp type fittings shall not be used.

E. Aluminum material may be used where the installation of dissimilar metals creates problems. The Contractor shall field verify all materials involved in the total installation and shall install system in accordance with all applicable NFPA and U.L. codes and standards.

3.00 EXECUTION

3.01 INSTALLATION

A. The Shop Drawings shall indicate the extent and general arrangement of the lightning protection system. If any departures from the Shop Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Lightning protection systems for all applications shall conform to National Fire Protection Association Code No. 780 and the NEC, whichever is more stringent.

B. Installation shall be performed by a certified master installer. Installer shall provide an Underwriters' Laboratories Master Label for the facilities.

C. Air terminals shall be provided on the highest projections and at intervals not exceeding 20 feet along the perimeter top surface. Air terminals shall extend at least 10 inches above the object or area that they are intended to protect. Air terminals shall be connected to the lightning protection system when specifically authorized by the Engineer.

D. Roof and down conductors shall be stranded and shall meet the requirements given in NFPA 780. Roof and down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius of less than eight inches. Conductors shall be routed external to buildings and six feet or more from power or signal conductors. Down conductors shall be routed outside of any structure and shall not penetrate or invade that structure. All down conductors except one may be provided with a screw type connector as described in UL 96 where lightning protection system testing may be required. Down connectors shall be supported from and secured to the building exterior using one hole straps of copper or bronze at maximum intervals of three feet.

E. Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged. Guards shall extend at least six feet above and one foot below grade level. Guards shall be metal pipe. Metal guards shall be bonded to the down conductor at both ends. Bonding jumpers shall be of the same size as the down conductor. Crimp type fittings shall not be used.

F. Metallic bodies, on or below roof level, that are subject to induced charges from lightning include exhaust fans, radio towers, HVAC units, ladders, railings, antennas, roof drains, plumbing, vents, metal coping, metal flashing, gutters, downspouts, small metal wall vents, door and window frames, metal balcony railings, and in general any isolated metallic body within six feet of an exposed lightning protection system element. When these metallic bodies have a metal thickness of 3/16 inch or greater, they shall be bonded to the nearest main lightning protection system conductor with UL approved fittings and conductors meeting the requirements of NFPA 780. These bonding fittings shall provide surfaces of not less than three square inches. Provisions shall be made to prevent corrosive effects introduced by galvanic action of dissimilar metals at bonding points. If the metal parts of these units are less than 3/16 inch thick, additional approved air terminals, conductors and fittings, providing a two way path to ground from the air terminals shall be installed.

G. If metallic, the mast of roof mounted antennas and obstruction lightning shall be bonded to the nearest roof or down conductor using UL approved fittings and conductors. The

bonding jumpers shall be of the same size and material as the roof or down conductor to which they are connected. Provide as a minimum a path to ground at each corner of the building.

H. Aluminum material may be used where the installation of dissimilar metals creates problems. The Contractor shall field verify all materials involved in the total installation and shall install system in accordance with all applicable NFPA and U.L. codes and standards.

3.02 FIELD QUALITY CONTROL

A. The lightning protection system will be inspected by the Engineer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Engineer.

B. The Contractor shall establish and maintain quality control for the "Lightning Protection System" installation to assure compliance with contract requirements, and shall maintain records of his quality control for all construction operations. A copy of these records and Contractor tests, as well as records of corrective action taken, shall be furnished to Owner's Representative, as directed by the Engineer.

C. Contractor shall obtain an Underwriters' Laboratories Master Label for the facility.

1. Upon completion, an application shall be made to the Underwriters Laboratories, Inc. for inspection and certification.

2. Cost for UL inspection and associated costs to obtain the UL Master Label shall be paid for by the Contractor.

D. Testing of Continuity of all Conductors - A copy of these records and tests, as well as the records of corrective action taken, shall be furnished to Owner's Representative, as directed by the Engineer.

END OF SECTION

26 50 00 LIGHTING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install light fixtures, complete with lamps, ballasts and other incidentals. Electrical work shall be in accordance with Section 26 05 00, “Common Work Results for Electrical”.

1.02 QUALITY ASSURANCE

A. ACCEPTABLE MANUFACTURERS

Lamps shall comply with the specifications and shall be by the following Manufacturers:

1. General Electric
2. Sylvania

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include Shop Drawings:

1. Refer to the Lighting Fixture Schedule for the manufacturer and model number for each type of fixture. Submittals with alternate manufacturers than those listed in the lighting fixture schedule will not be reviewed and will be returned without review.
2. Bill of Material
3. Product data sheets for each fixture type:
    a. Product data sheets shall be marked for each fixture type, arranged in the order of the fixture designation.
    b. Product data for fixtures, lamps, ballasts, drivers and emergency lighting units.
    c. Outline drawings indicating dimensions and principal features of the fixture.
    d. Electrical ratings and photometric data provided by certified laboratory tests for the fixture and lamps.
    e. Provide data on LED Fixture indicating it is rated for maintained 70% lumen output at 60,000 hours.

1.04 DELIVERY AND STORAGE

A. Ship light fixtures inside protective cartons and keep packaged until installed. Deliver lamps to the job site in the original packing cases and sleeves.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.05 JOB CONDITIONS

A. Provide cold weather ballasts in fixtures which are subject to temperatures below 32 degrees F.

B. Provide special mounting, enclosures and fire-safing, as required by the authorities having jurisdiction so that the integrity of the U.L. listed ceiling assembles is maintained.

C. Provide U.L. labels where fixtures are subject to moisture. Provide DL or WL label on fixtures required for the location.

D. Contractor shall verify voltages with ballasts and power supplies prior to ordering fixtures.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.

5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than 5 years from date of Substantial Completion.

2.00 PRODUCTS

2.01 MATERIALS

A. LED DRIVERS AND LAMPS: Drivers and LED lamps shall be integral to the fixture. The fixture shall be rated for operating temperatures of -40°C to +60°C, UL wet location rated with frosted impact rated glass lens. Fixture shall be rated for maintained 70% lumen output at 60,000 hours.

B. POLES AND SUPPORT COMPONENTS:

1. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

2. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
    a. Materials: Shall not cause galvanic action at contact points.
    b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
    c. Anchor-Bolt Template: Plywood or steel.

3.00 EXECUTION

3.01 INSTALLATION

A. Provide the lighting fixtures, as specified and scheduled on the plans. If a type designation is omitted, verify the fixture selection with the Engineer before installation.

B. Check the architectural finishes and provide fixtures with proper trim, frames, support hangers and other hardware required to coordinate with the proper finishes, regardless of the specified or scheduled catalog number, prefixes and suffixes.

C. Test and aim flood lights, when dark outside to provide a uniform and widespread, illuminated area. Direct units as indicated or instructed by the Engineer to prevent objectionable glare.

D. Furnish and install a complete exterior lighting control system, as indicated on the plans. Provide materials and equipment to properly interface timing devices and photocells with relays and contactors so that a complete and satisfactory operating system is rendered.

3.02 CLEAN AND ADJUST

A. Immediately before final inspection, clean all fixtures, inside and out, including plastics and glassware. Adjust all trim to properly fit adjacent surfaces. Replace broken or damaged parts. Lamp and test all fixtures for electrical, as well as, mechanical operation.

3.03 SPARE PARTS

A. LED Driver: Furnish at least one of each type.

B. Globes and Guards: Furnish at least one of each type.

END OF SECTION

31 05 13 SOILS FOR EARTHWORK

1.00 GENERAL

1.01 WORK INCLUDED

A. This Section of the specifications describes the various classes of Earth Fill. All of the classes of Earth Fill contained in this specification may not be used on this project. The classes of Earth Fill used on this project are shown on the drawings or specified in other sections of the specifications. This Section does not include specifications for placement and compaction of Earth Fill. Specifications for placement and compaction of Earth Fill are included in other sections of the specifications and/or shown on the drawings.

1.02 STANDARDS

A. Soil materials shall be classified into the appropriate class of Earth Fill shown below according to ASTM D2487 "Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)" or other appropriate methods as designated by the Engineer.

2.00 PRODUCTS

2.01 MATERIALS; CLASSIFICATIONS

A. Class 1 Earth Fill: Limited to clays and sandy clays classified as CH material with a liquid limit greater than or equal to 50, a plasticity index greater than or equal to 25, and a minimum of 60 percent passing the No. 200 sieve, which are free of organic materials.

B. Class 2 Earth Fill: Limited to clays and sandy clays classified as CH and CL materials with a coefficient of permeability less than or equal to 1.0×10^{-7} cm/sec, a liquid limit greater than or equal to 30, a plasticity index greater than or equal to 15, and more than 50 percent passing the No. 200 sieve, which are free of organic materials.

C. Class 3 Earth Fill: Consist of any materials classified as CH, CL, SM, SP, SP-SM, SC, and GC, which have a minimum plasticity index of 4, which are free of organic materials.

D. Class 4 Earth Fill: Consist of materials which are classified as SP, SM, SC, CL, or dual classifications thereof, which have a liquid limit less than or equal to 35 and a plasticity index between a minimum of 4 and a maximum of 15, a minimum of 70 percent passing the No. 200 sieve, a maximum aggregate size of 2 inches, which are free of organic materials.

E. Class 5 Earth Fill: Consist of materials classified as SP or SP-SM which have a plasticity index less than or equal to 4 and a maximum of 12 percent passing the No. 200 sieve, which are free of organic materials.

F. Class 12 Earth Fill: Consist of soils suitable for topsoil which are relatively free of stones or other objectionable debris, which have sufficient humus content to readily support vegetative growth. The suitability of soils for topsoil shall be subject to the approval of the Engineer.

3.00 EXECUTION (NOT APPLICABLE)

END OF SECTION

31 05 16 AGGREGATES FOR EARTHWORK

1.00 GENERAL

1.01 WORK INCLUDED

A. This Section of the specifications describes the various classes of Aggregate Fill. All of the classes of Aggregate Fill contained in this specification may not be used on this project. The classes of Aggregate Fill used on this project are shown on the drawings or specified in other sections of the specifications. This Section does not include installation. Installation of Aggregate Fill is included in other sections of the specifications and/or on the drawings.

1.02 QUALITY ASSURANCE

A. Classification Testing:

1. Contractor Testing:

a. Arrange and pay for the services of an independent testing laboratory to sample and test proposed Aggregate Fill materials.

b. Submit the test results to the Engineer, and obtain approval prior to providing Aggregate Fill.

2. Owner Testing: The Owner shall arrange and pay for additional testing on the Aggregate Fill after delivery to the project site as determined necessary by the Engineer.

B. Contamination Certification:

1. Obtain a written, notarized certification from the Supplier of each proposed Aggregate Fill source stating that to the best of the Supplier's knowledge and belief there has never been contamination of the source with hazardous or toxic materials.

2. Submit these certifications to the Engineer prior to proceeding to furnish Aggregate Fill to the site. The lack of such certification on a potential Aggregate Fill source shall be cause for rejection of that source.

1.03 STANDARDS

A. Aggregate Fill shall be classified into the appropriate class listed below according to ASTM testing procedures as specified for the various classes.

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Specification for Concrete Aggregates
ASTM C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium sulfate
ASTM C125	Terminology Relating to Concrete and Concrete Aggregates
ASTM C131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C535	Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D448	Classification for Sizes of Aggregate for Road and Bridge Construction

2.00 PRODUCTS

2.01 MATERIALS; CLASSIFICATIONS

A. Class 1 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 57:

Sieve Size Square Opening	Percent Passing
1-1/2”	100
1”	95-100
1/2”	25-60
No. 4	0-10
No. 8	0-5

B. Class 2 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 67:

Sieve Size Square Opening	Percent Passing
1”	100
3/4”	90-100
3/8”	20-55
No. 4	0-10
No. 8	0-5

C. Class 3 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 7:

Sieve Size Square Opening	Percent Passing
3/4”	100
1/2”	90-100
3/8”	40-70
No. 4	0-15
No. 8	0-5

D. Class 4 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 467:

Sieve Size Square Opening	Percent Passing
2”	100
1-1/2”	95-100
3/4”	35-70
3/8”	10-30
No. 4	0-5

E. Class 5 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 357:

Sieve Size Square Opening	Percent Passing
2-1/2”	100
2”	95-100
1”	35-70
1/2”	10-30
No. 4	0-5

F. Class 6 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material

shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 1:

Sieve Size Square Opening	Percent Passing
4”	100
3-1/2”	90-100
2-1/2”	25-60
1-1/2”	0-15
3/4”	0-5

G. Class 7 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and shall have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 6:

Sieve Size Square Opening	Percent Passing
1”	100
3/4”	90-100
1/2”	20-55
3/8”	0-15
No. 4	0-5

H. Class 8 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and shall have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 56:

Sieve Size Square Opening	Percent Passing
1-1/2”	100
1”	90-100
3/4”	40-85
1/2”	10-40
3/8”	0-15
No. 4	0-5

I. Class 9 Aggregate Fill:

1. Consist of washed and screened gravel and natural sands or sands manufactured by crushing stones complying with the requirements of ASTM C33, except that the gradation shall be as follows:

Sieve Size Square Opening	Percent Passing
1/2”	100
3/8”	95-100
No. 4	80-95
No. 8	65-85
No. 16	50-75
No. 30	25-60
No. 50	10-30
No. 100	0-10

2. Class 9 Aggregate Fill shall have not more than 45 percent passing any sieve and retained on the next consecutive sieve of those shown above, and its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

J. Class 10 Aggregate Fill:

1. Consist of washed and screened natural sands or sands manufactured by crushing stones complying with the requirements and tests of ASTM C33. The gradation as included in ASTM C33 is as follows:

Sieve Size Square Opening	Percent Passing
3/8”	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	0-10

2. Class 10 Aggregate Fill shall have not more than 45 percent passing any sieve and retained on the next consecutive sieve of those shown above, and its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

K. Class 11 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable material and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution,

the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation:

Sieve Size Square Opening	Percent Passing
1-3/4”	100
7/8”	65-90
3/8”	50-70
No. 4	35-55
No. 40	15-30
No. 100	0-12 (Wet Sieve Method)

L. Class 12 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable material and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation:

Sieve Size Square Opening	Percent Passing
1-1/2”	100
1”	85-100
3/4”	60-95
3/8”	50-80
No. 4	40-65
No. 16	20-40
No. 100	0-12 (Wet Sieve Method)

M. Class 13 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable material and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and shall meet the following gradation:

Sieve Size Square Opening	Percent Passing
1-3/4”	100
7/8”	65-90
3/8”	50-70
No. 4	35-55
No. 40	15-30
No. 100	0-3 (Wet Sieve Method)

N. Class 14 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable material and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation:

Sieve Size Square Opening	Percent Passing
1-1/2”	100
1”	85-100
3/4”	60-95
3/8”	50-80
No. 4	40-65
No. 16	20-40
No. 100	0-3 (Wet Sieve Method)

O. Class 15 Aggregate Fill: Consist of durable particles of silica sand, washed clean, chemically inert, and packaged by the Supplier. The material shall meet applicable regulatory requirements for monitor well filter pack. The source of the material shall be approved by the Engineer and shall meet the following gradation requirements:

Sieve Size Square Opening	Percent Passing
No. 20	98-100
No. 40	0-2

3.00 EXECUTION (NOT APPLICABLE)

END OF SECTION

31 11 00 CLEARING AND GRUBBING [CIVIL]

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to perform operations in connection with clearing, grubbing, and disposal of cleared and grubbed materials.

1.02 QUALITY ASSURANCE; DEFINITIONS

A. Clearing: Clearing is defined as the removal of trees, shrubs, bushes, and other organic matter at or above original ground level.

B. Grubbing: Grubbing is defined as the removal of stumps, roots, boards, logs, and other organic matter found at or below ground level.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 PREPARATION

A. Mark areas to be cleared and grubbed prior to commencing clearing operations. The Owner's Representative shall approve clearing and grubbing limits prior to commencement of clearing operations.

B. Trees and shrubs outside of the clearing limits, which are within 10 feet of the clearing limits, shall be clearly marked to avoid damage during clearing and grubbing operations.

C. Remove trees and brush outside the clearing limits, but within the immediate vicinity of the work, upon receipt of approval by the Owner's Representative, when the trees or brush interfere with the progress of construction operations.

D. Clearly mark trees and shrubs within the clearing limits, which are to remain, and protect the trees and shrubs from damage during the clearing and grubbing operations.

E. The clearing limits shall not extend beyond the project limits.

F. Establish the clearing limits as follows:

1. Embankments plus 10 feet beyond the toe of the embankment.
2. Excavations plus 5 feet beyond the top of the excavation.
3. Concrete structures plus 10 feet beyond the edge of the footing.
4. Roadways, runways, taxiways, and parking areas plus 5 feet beyond the edge of pavement or R.O.W. limits.
5. Retaining walls plus 10 feet beyond the edge of the footing.
6. Underground utility trench top width plus 8 feet.

G. Establish the grubbing limits as follows:

1. Embankments plus 2 feet beyond the toe of the embankment.

2. Concrete structures plus 2 feet beyond the edge of the footing.
3. Roadways, runways, taxiways, and parking areas plus 1 foot beyond the edge of pavement.
4. Retaining walls plus 2 feet beyond the edge of the footing.

3.02 INSTALLATION

A. Clearing: Clearing shall consist of the felling, cutting up, and the satisfactory disposal of trees and other vegetation, together with the down timber, snags, brush, rubbish, fences, and debris occurring within the area to be cleared.

B. Grubbing:

1. Grubbing shall consist of the removal and disposal of stumps and roots larger than 1 inch in diameter.
2. Extend grubbing to the depth indicated below: In the case of multiple construction items, the greater depth shall apply.
    a. Footings: 18 inches below the bottom of the footing.
    b. Walks: 12 inches below the bottom of the walk.
    c. Roads and Taxiways: 18 inches below the bottom of the subgrade.
    d. Parking Areas: 12 inches below the bottom of the subgrade.
    e. Embankments: 24 inches below existing ground.
    f. Concrete Structures: 18 inches below the bottom of the concrete.
    g. Retaining Walls: 18 inches below the bottom of the footing.

3.03 FIELD QUALITY CONTROL

A. Completely remove timber, logs, roots, brush, rotten wood, and other refuse from the Owner's property. Disposal of materials in streams shall not be permitted and no materials shall be piled in stream channels or in areas where it might be washed away by floods. Timber within the area to be cleared shall become the property of the Contractor, and the Contractor may cut, trim, hew, saw, or otherwise dress felled timber within the limits of the Owner's property, provided timber and waste material is disposed of in a satisfactory manner. Materials shall be removed from the site daily, unless permission is granted by the Engineer to store the materials for longer periods.

END OF SECTION

31 23 10 STRUCTURAL EXCAVATION AND BACKFILL

1.00 GENERAL

1.01 SUMMARY

A. This Section specifies excavation, backfill materials, backfill placement and compaction procedures, and other construction activities incidental to project structures.

1.02 QUALIFICATION ASSURANCE

A. Testing Agency: An independent testing agency that is AASHTO accredited.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Qualification Data: For testing agency.
2. Provide list of compaction equipment to be used.
3. Backfill material classifications: For each soil or aggregate backfill material provide a certification by the testing agency.
4. Compaction Test Results: Submit test results within 24 hours of successful testing.

1.04 STANDARDS

A. Material classification, placing, and testing shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents.

1. ASTM International (ASTM) Standards:

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Any other testing required by these specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards as designated by the Engineer.

1.05 DELIVERY AND STORAGE

A. Deposit material to be used for backfill in storage piles at points convenient for handling of the material during the backfilling operations and as required to prevent contamination with other materials.

1.06 JOB CONDITIONS

A. Review subsurface investigations. A limited subsurface investigation has been performed by Freese and Nichols, Inc. Boring logs from that investigation are available at the Engineer's office for information purposes only. The precise profile of soil and rock strata beneath this Site is not known.

B. Review the Site and determine the conditions which may affect the structural excavation, prior to the commencement of the excavation.

2.00 PRODUCTS

2.01 BACKFILL MATERIALS

A. Select Fill: Select fill shall be Class 4 Earth Fill as specified in Section 31 05 13 "Soils for Earthwork."

B. Structural Fill: Structural fill shall be crushed limestone base material conforming to TxDOT Standard Specification Item 247, Type A, Grade 1 or 2.

C. Clay Cap: Clay cap material shall be Class 2 Earth Fill.

D. Mud Slab: Lean concrete in accordance with Section 03 30 00 "Cast-In-Place Concrete."

E. Flowable Fill: Flowable fill shall be in accordance with Section 31 23 23.34 "Flowable Fill."

F. General Fill: On-site native clayey soils, maximum aggregate size of 2 inches, which are free of organics.

G. Topsoil: Topsoil shall be Class 12 Earth Fill as specified in Section 31 05 13 "Soils for Earthwork."

H. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand, or recycled, crushed concrete (in accordance with TxDOT Item 247, Type D); ASTM D448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and 5 to 15 percent passing No. 200 sieve; maximum plasticity index of 7; complying with deleterious substance limits of ASTM C33 for fine aggregates.

1. Provide a minimum 3-inch layer of compacted Fine-Graded Granular Material for a levelling course for slab-on-grade.

2.02 COMPACTION EQUIPMENT

A. Compaction equipment shall conform to the following requirements.

1. Heavy Compaction Equipment:

a. Tamping Compactor: Steel wheels with rectangular face, tapered pads that prevent fluffing the soil. Compactor shall be equipped with cleaning fingers to remove soil accumulation from between pads.

1). Operating Weight, Minimum: 30,000 pounds.

2). Wheels or Drum Size, Minimum: 4 feet diameter.

3). Travel Speed, Maximum: 10 mph.

b. Pneumatic Rollers: Minimum eight-tire, pneumatic roller with a modular ballast system and flexible operating weight, and which will equally distribute load between tires to provide compaction uniformity.

1). Operating Weight Range: As required for specified compaction, 36,000 to 50,000 pounds.

2). Tire Pressure Range: 80 psi to 100 psi.

3). Travel Speed, Maximum: 10 mph.

4). Distance Between Edges of Adjacent Tires: Less than 50 percent of tire width.

c. Vibratory Rollers: Smooth drum roller with 90 percent of the static weight transmitted through a single drum.

1). Static Weight, Minimum: 20,000 pounds

2). Centrifugal Force Per Drum, Minimum: 40,000 pounds

3). Frequency: 1400 v/min

4). Drum Size: Diameter 5 feet, +/- 1 foot; width between 6 and 9 feet.

5). Travel Speed: 5 mph for self-propelled; 2 mph for towed.

6). No backing up of the vibratory roller will be allowed on an embankment unless the vibrating mechanism is capable of being reversed.

2. Hand-Directed Compaction Equipment: Use power tampers and vibratory plate compactors in areas where it is impracticable or unacceptable to use heavy compaction equipment.

3.00 EXECUTION

3.01 PREPARATION

A. Clear and grub the area to be excavated prior to the start of excavation as specified in Section 31 11 00 “Clearing and Grubbing.” Remove the surficial vegetation, waste and soils to a minimum depth of 6 inches. Depth of removal shall not be less than that required to remove trees, shrubs, stumps, roots, and other organic material above and below ground from within the area to be excavated. Ensure below grade organic material is removed to a minimum depth of 18 inches below bottom of footing/structure.

3.02 EXCAVATION FOR FOUNDATIONS

A. General: Excavate subgrade to the depth indicated on Drawings, +/- 0.1 feet tolerance. Extend limits of the excavation beyond the perimeter of the foundations as indicated on the Drawings.

1. Exposed subgrade surfaces shall be level and of sound, stable material; free of mud, frost, snow, or ice. Testing agency or Owner’s representative shall confirm exposed subgrade is a suitable bearing material based on the Construction Documents.

2. Proof roll the exposed subgrade in accordance with TxDOT Item 216. Do not proof roll wet or saturated subgrades.

3. Where unsound or unstable material is uncovered, notify Owner's representative Remove objectionable material and replace after approval is received from Owner's representative. Replacement material shall be as indicated here unless otherwise indicated on Drawings:

    a. Rock subgrade replacement material: Flowable fill.

    b. Soil subgrade replacement material: Compacted select fill.

B. Mud Slab: Where indicated, install mud slab on exposed foundation subgrade surface within 8 hours of subgrade exposure. Confirm subgrade is free of loose, unsound, and/or deleterious material before placement of mud slab.

C. Excavation Safety: All excavations shall be in accordance with OSHA requirements.

3.03 WATER IN FOUNDATION EXCAVATIONS

A. General:

1. Prevent water infiltration into foundation excavations. Remove standing water from excavation prior to placing concrete. If removal of standing water is not possible due to continuous water infiltration, then contact Owner's representative for additional direction regarding placing concrete underwater.

2. Do not dewater a foundation excavation while placing concrete or for a period of at least 24 hours after concrete placement.

B. Rock Foundation Subgrade: If rock material becomes weathered due to water infiltration, then remove weathered material and provide rock replacement material to restore foundation subgrade elevation.

C. Soil Foundation Subgrade: If foundation subgrade becomes saturated do not disturb the subgrade. Wait for water to evacuate the subgrade and subgrade surface to adequately stiffen prior to placing concrete. If subgrade is disturbed, then wait until subgrade has dried out, excavate disturbed subgrade and provide replacement material as indicated above.

3.04 COMPACTED BACKFILL

A. General: Backfill excavated spaces and areas not occupied by the permanent structure.

1. Backfill behind a retaining wall or basement-type wall shall not be placed until the concrete has reached its 28-day compressive strength or 7 days, whichever is longer.

2. Unless otherwise indicated on Drawings, structures with a top slab shall not backfilled until the top slab has been in place at least 4 days.

3. Structures with soil on opposing (opposite) sides shall be backfilled to prevent uneven loading of the structure – evenly raise backfill on opposing sides of the structure. The maximum differential backfill height between opposing sides is 1 foot.

4. Do not permit rollers to operate within **3** feet of structures.

5. Maximum Loose Lift Height:

    a. Heavy Compaction Equipment: 8 inches.

    b. Hand-Directed Compaction Equipment: 4 inches.

6. Previous Compacted Layer: If backfill placement occurs over a period of time greater than 24 hours, then scarify and recompact the previous day's final compacted layer.
    a. Scarify and Recompact: 6-inch depth; adjust the moisture content; recompact.
    b. Saturated subgrades shall not be worked on until sufficiently dry and harden so as not to be rutted with compaction equipment. Scarify and recompact layers damaged by weather or construction equipment.

B. Moisture: Prior to compacting backfill, mix and aerate or water the loose lift backfill material as necessary to adjust the moisture content and evenly distribute throughout. The material shall contain moisture within the limits specified below.
    1. In accordance with ASTM D6938, determine the optimum moisture content for the maximum dry density.
    2. Backfill moisture content shall be as indicated in Table 1, "Compacted Fill."
    3. Aggregate fill: Completely cohesionless materials, shall be at a moisture content which will allow use of the specified compaction equipment and consistent achievement of the specified density.

C. Compaction: As required to achieve the specified density, increase the number of passes above the minimum specified and/or modify the weight of the equipment.
    1. Determine the maximum dry density in accordance with ASTM D698 for cohesive soils and ASTM D4253 for cohesionless soils.
    2. Minimum number of passes for all compacted fill types: 8.
    3. Cohesive Soils: A tamping compactor or tamping compactor followed by a pneumatic roller shall be used.
    4. Cohesionless or low cohesive soils: A vibratory roller or vibratory plate compactors shall be required if the material is cohesionless or with less than 15 percent passing the No. 200 sieve. Confirm applicability of vibratory compaction equipment in the field.
    5. Overlap passes a minimum of 1 feet for heavy compaction equipment and 50 percent of the baseplate width for hand-directed equipment.
    6. Backfill density shall be as indicated in Table 1, "Compacted Fill."

Table 1: Compacted Fill

Backfill Type	Density[1,2]	Moisture Content[3, 4]	Comments
Classes 1 & 2	95%	-0% to +5%	N/A
Classes 3 & 4 & 5	95% to 100%	-2% to +3%	N/A
Structural Fill	100%	-2% to +1%	N/A
Fine Graded Granular Material	98%	See Note 4	N/A

[1] The percentage indicated is the minimum required percentage of the maximum dry density as determined by the applicable ASTM.
[2] Below Vehicular Pavement: Scarify to a depth of 8, moisture condition, and recompact to not less than 100 percent of the maximum dry density.
[3] Range indicated is the acceptable tolerance with respect to the optimum moisture content.

[4] Completely cohesionless materials, shall be at a moisture content which will allow use of the specified compaction equipment and result in consistent achievement of the specified density.

3.05 FIELD QUALITY CONTROL

A. Contractor is responsible for the costs involved in providing an approved testing agency to perform quality control testing of backfill operations and verification of subgrade bearing material. The testing laboratory shall make tests of in-place density and moisture in accordance with ASTM Standards previously mentioned in this Section. The testing agency shall monitor backfill operations continuously or at intervals acceptable to the Owner's representative. It shall be the responsibility of the Contractor to notify the testing agency a minimum of two business days before backfill operations begin.

1. Unless noted otherwise, in-place density tests shall be conducted at a rate of one test per 3000 square feet for every lift, with a minimum of three tests for every lift.

END OF SECTION

31 23 23.34 FLOWABLE FILL

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to mix and place flowable fill, consisting of Portland cement, fine aggregate, fly ash, and water in the proper proportions as specified hereinafter. Flowable fill (Controlled Low-Strength Material, CLSM) shall be used to bed and backfill around piping, utilities, and structures where indicated.

1.02 QUALITY ASSURANCE

A. Design Criteria – Flowable Fill Proportions and Consistency: Flowable fill shall be proportioned to give the necessary workability, strength, and consistency, and shall conform to the following governing requirements:

1. Permeability: Maximum permeability limit of $1x10^{-6}$ cm/sec. This limit shall apply at all locations where flowable fill is used as a utility trench plug (dam) within trench backfill materials.

1. Subsidence: Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per ft.) of flowable fill depth. Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C940.

2. Strength for Excavatable Flowable Fill: Unconfined compressive strength at 28-days when tested in accordance with ASTM D4832: 100 psi (+/- 50 psi).

   a. Long-term strengths (greater than 90 days) shall not exceed 150 psi.

   b. Where indicated provide Excavatable Flowable Fill around utilities, unless noted otherwise.

   c. Excavatable Flowable Fill shall be excavatable with hand tools and conventional machinery such as backhoes.

3. Strength for Non-Excavatable Flowable Fill: Unconfined compressive strength at 28-days when tested in accordance with ASTM D4832: 150 psi minimum.

   a. Where indicated provide Non-Excavatable Flowable Fill below structures and/or around structures, unless noted otherwise.

4. Fluidity: Flowable fill shall be self-consolidating and non-segregating in accordance with ASTM C1611:

   a. Slump Flow Test: Minimum 20-inch mean spread.

   b. Visual Stability Index (VSI) Test: Less than or equal to 1.

5. Density, minimum: 100 pcf

B. Factory Testing: The Contractor shall be responsible for the design of the material. A trial mix shall be designed by an independent testing laboratory, retained by the Contractor. The testing laboratory shall submit verification that the materials and proportions of the trial mix design meets the requirement of the Specifications. In lieu of trial mix design, Contractor may submit historical data for a mix design used successfully in previous similar

work. The Contractor shall not make changes in materials, either in gradation, source, or brand, or proportions of the mixture after having been approved, except by specific approval of the Engineer.

C. Owner Testing: It is the responsibility of the Contractor to achieve and maintain the quality of material required by this Section. However, the Owner may secure the services of an independent testing laboratory to verify the quality of the flowable fill. The Owner shall have the right to require additional testing, strengthening, or replacement of flowable fill which has failed to meet the minimum requirements of this Section.

1.03 SUBMITTALS

A. Submit mix design on each material required. Provide backup data as required below.

B. Submit historical or trial mix data and test results as a basis for mix design approval. Required data shall include:

1. Permeability test results if plugs are required on Project.
2. Subsidence test results.
3. Strength test results for Excavatable and Non-Excavatable Flowable Fill if used on Project.
4. Fluidity test results.

1.04 STANDARDS AND REFERENCES

A. Materials shall meet recommendation for mix design and placement, as published by National Ready Mixed Concrete Association.

B. The applicable provisions of the following references and standards shall apply to this Section as if written herein in their entirety.

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Specification for Concrete Aggregates
ASTM C40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C150	Specification for Portland Cement
ASTM C618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
ASTM C940	Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1611	Standard Test Method for Slump flow of Self Consolidating Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

2.00 PRODUCTS

2.01 MATERIALS

A. Cement: ASTM C150, Type I or II.

B. Fly Ash/Pozzolans: ASTM C618, Class C.

C. Fine Aggregate: ASTM C33, fine aggregate.

1. ASTM C40: Aggregate shall not contain strong alkali, or organic material which gives a color darker than the standard color.

D. Water: Potable and in conformance with ASTM C1602 and ASTM C1602, Table 2.

E. Performance Additive: As required to meet specification requirements:

1. DaraFill by GCP Applied Technologies.

2. MasterCell 25 by BASF The Chemical Company.

3. Sika Lightcrete Powder by Sika Corporation.

4. Approved equal.

F. Chemical Admixtures for Concrete per ASTM C494, as required by performance requirements.

2.02 MIXES

A. In the determination of the amount of water required for mix, consideration shall be given to the moisture content of the aggregate. The net amount of water in the mix will be the amount added at the mixer; plus the free water in the aggregate; and minus the absorption of the aggregate, based on a 30 minute absorption period. No water allowance shall be made for evaporation after batching.

B. The methods of measurement of materials shall be such that the proportions of water to cement are closely controlled during the progress of the Work and easily checked at any time by the Owner's representative. To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from sources which will insure a uniform quality and grading during any single day's operation and they shall be delivered to the Work and handled in such a manner that the variation in moisture content will not interfere with the steady production of flowable fill of reasonable degree of uniformity. Sources of supply shall be approved by the Owner's representative.

C. All material shall be separately and accurately measured. All equipment for measurement of materials shall be subject to approval by the Owner's representative.

3.00 EXECUTION

3.01 INSTALLATION

A. Contractor shall give the Owner's representative sufficient advance notice before starting to place material in any area, to permit inspection of the area, and preparation for pouring.

B. Conduct the operation of depositing the material so as to form a well consolidated mass and so as not to develop air pockets in confined spaces.

C. Unless specified otherwise, flowable fill shall be uniformly placed to the depth shown on the Drawings. The fill shall be brought up uniformly to the top of excavation elevation or as otherwise indicated on the Drawings. Placement of flowable fill shall then cease and the fill protected from traffic for a period of not less than 72 hours.

1. To prevent pipe flotation place material in lifts or provide alternate means.
2. Around structures, material shall be placed in lifts. Lift depth shall not exceed one-tenth of total structure embedment into subgrade nor 3 feet, whichever is less.
3. When multiple lifts are required, material shall be allowed to harden before placing next lift. Hardening time varies with each mix. Verify flowable fill has reached a penetration number of 1500, in accordance with ASTM C403, but not less than 3 hours.

D. The material shall be placed against undisturbed trench walls, and shall not be placed on or against frozen ground.

E. At time of placement the ambient temperature shall be 35 F and rising.

3.02 FIELD QUALITY CONTROL

A. An approved testing laboratory shall perform the quality control testing of backfill operations. The testing laboratory shall sample material in accordance with ASTM D5971. The testing laboratory shall monitor backfill operation continuously or at intervals acceptable to the Owner and Engineer at structures. It shall be the responsibility of the Owner to provide sufficient advance notification to the testing laboratory before backfill operations begin.

1. Strength: A strength test is the average of two cylinders per ASTM D4832.
2. Fluidity: A fluidity test is a Slump Flow Test and a VSI Test per ASTM C1611.
3. For all tests required, at a minimum perform one test per day, but not less than one per 150 cubic yards.

END OF SECTION

31 23 33.14 TRENCH SAFETY

1.00 GENERAL

1.01 WORK INCLUDED

A. This specification consists of the basic requirements which the Contractor must comply with in order to provide for the safety and health of workers in a trench. This specification is for the purpose of providing minimum performance specifications, and the Contractor shall develop, design, and implement the trench safety system. The Contractor shall bear the sole responsibility for the adequacy of the trench safety system and providing "a safe place to work" for the workman.

B. Should the trench safety protection system require wider trenches than specified elsewhere, the Contractor shall be responsible for the costs associated with determining adequacy of pipe bedding and class, as well as, purchase and installation of alternate materials.

1.02 STANDARDS

A. The following standard shall be the minimum governing requirement of this specification and is hereby made a part of this specification as if written in its entirety.

1. Occupational Safety and Health Standards - Excavations (29CFR Part 1926), U.S. Department of Labor, latest edition.

B. Comply with the applicable Federal, State, and local rules, regulations, and ordinances.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION (NOT APPLICABLE)

END OF SECTION

31 23 33.19 TRENCHING AND BACKFILL [PLANT CONSTRUCTION]

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to perform operations in clearing, grubbing and Site preparation; trenching, pipe bedding, and backfilling; handling, storage, transportation and disposal of excavated material; pumping and dewatering; preparation of subgrades; protection of adjacent facilities and property; and other appurtenant work.

B. Trenching, backfilling, and pipe embedment procedures shall be in full compliance with Section 31 23 33.14 “Trench Safety.”

C. Earth removed from excavations and that is not required for backfill, shall be removed from the Site by the Contractor at his own expense, unless arrangements are made with the Owner through his representative to allow disposal on -Site. If permitted, the Contractor shall dump and spread excess earth in a manner agreed upon by the Contractor and Owner.

D. General and structural excavation and backfill shall be as specified in other sections.

1.02 QUALITY ASSURANCE; CLASSIFICATION

A. Excavations shall include material of whatever nature encountered, including but not limited to clays, sands, gravels, conglomeritic boulders, weathered clay shales, rock, debris and abandoned existing structures. Excavation and trenching shall include the removal and subsequent handling of materials excavated or otherwise handled in the performance of the Work.

B. Bidders must satisfy themselves as to the actual existing subsurface conditions prior to the submittal of a proposal to complete the proposed Work. No extra or separate payments shall be made for rock, dewatering, or any other condition.

C. Trench excavation shall consist of excavation to the lines and grades indicated, required for installation of the pipe, pipe bedding, backfill, and to accommodate trench safety systems.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Submittal Procedures” and shall include:

1. Certified test reports for embedment material, backfill material, coarse gravel, and flexbase. Certified Test Reports shall be from an independent laboratory. Test reports shall include sieve analysis, and Atterburg limits, and other tests as required to demonstrate compliance with Paragraph 2.01.

2. Test results indicating soil resistivity for embedment material used on metal pipe.

3. Field density test reports indicating that the Contractor’s method of backfill meets the requirements of the Contract Documents. The field density testing for granular embedment shall be done in a manner approved by the Owner/Engineer by an independent testing lab in accordance with ASTM D4253. The cost of the field testing

shall be included in the Bid Price for the Work, with no additional compensation to the Contractor.

1.04 STANDARDS

A. The following publications, referred to hereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Standard Specification for Concrete Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3
ASTM D1556	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D3017	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D4253	Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM G57	Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

2. American Water Works Association (AWWA) Standards:

AWWA C151	Ductile Iron Pipe
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C301	Prestressed Concrete Pressure Pipe - Steel Cylinder Type for Water and Other Liquids
AWWA C303	Concrete Pressure Pipe – Steel Cylinder Type for Water and other Liquids

3. Texas Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

B. Any other testing required by these Specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards as designated by the Engineer.

C. Reference herein or on the Drawings to soil classifications shall be understood to be according to ASTM D2487, Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.05 DELIVERY AND STORAGE

A. Excavated and delivered materials to be used for backfill may be deposited in stockpiles at points convenient for rehandling the material during the backfilling process. If not indicated on the Drawings, the location of stockpiles shall be within the limits of construction easements or public right-of-way. The location of stockpiles is subject to the approval of the Owner or the Owner's representative. Do not place stockpiles over buried pipelines or utilities unless adequate provisions are made for protection. Roads and driveways must be kept open unless written authorization is granted by Owner. Keep drainage channels clear of stockpiled materials or make other satisfactory provisions for drainage.

1.06 JOB CONDITIONS

A. Classification of Excavation: Excavation shall be "unclassified" and involves the removing of the necessary materials to provide the trench/excavation to the required width and depth. The Contractor, prior to submitting a proposal, must satisfy himself as to the actual sub-surface conditions. No extra or separate payments shall be made for rock, dewatering or any other condition.

B. City, County, and Private Road Crossings: Where the Work is in the right-of-way of City, County and privately owned roads, the Contractor shall secure Street Cut Permits and all other required permits. Work to be performed within the limits of the public right of way shall be in full accordance with the requirements of the easements and permits and as requested by the City, County, or private owner. Provide temporary access and detours for roads and driveways cut off during pipe laying operations.

C. Protection of Existing Structures and Utilities:

1. Prior to the start of construction, communicate with the local representatives of utilities companies, including but not limited to oil, gas, telephone, and communications companies, as well as, local water and sewer utilities operating in the location of the proposed construction area. Obtain the utility companies' assistance in locating existing facilities to avoid conflicts during construction. The location, number, depth, and owner of utilities indicated are for information purposes only, and all utilities and structures may not be shown or may not be in the location shown. The Contractor is responsible for verifying the actual locations and quantities of utilities and for protecting them during construction.

2. Where construction endangers adjacent structures, utilities, embankments and/or roadways, the Contractor shall carefully support and protect such facilities so that no damage occurs throughout the construction process. The cost of such protection shall be included in the Bid, and will not entitle Contractor to additional compensation. In case damage should occur, the Contractor shall be responsible for restoring the damaged item to a condition acceptable to the owner of that item and shall bear all cost of such reparations.

3. Repair or replace damaged street surfaces, driveways, sidewalks, curbs, gutters, fences, drainage structures, or other such facilities to the satisfaction of the Owner. Facilities shall be returned to a condition equal to or better than the original condition and of same or better material and quality.

4. Relocate minor utilities as necessary, at no additional cost to the Owner, in order to resolve conflicts with new Work. Minor utilities shall be defined as conduit less than or equal to 2-inch diameter and pressure piping less than or equal to 6-inch diameter. All proposed relocations shall be submitted in writing and approved by Owner or Owner's representative prior to accomplishing the Work.

D. Freezing Weather Condition: Place no embedment or backfill material during freezing weather or upon frozen subgrades. Place no frozen embedment or backfill materials.

2.00 PRODUCTS

2.01 MATERIALS

A. Concrete Embedment, Cap, Blocking, and Encasement: Where concrete embedment, cap, blocking, or encasement is indicated or requested by the Engineer, it shall be Class E as specified in Section 03 30 00 "Cast-In-Place Concrete" unless otherwise indicated.

B. Granular Embedment and Backfill: Granular embedment material shall be as specified in Section 31 05 16 "Aggregates for Earthwork."

C. Coarse Gravel: Where coarse gravel is required for water drainage, restoration of trench foundation, or other uses, it shall be crushed stone or gravel and in compliance with ASTM C33 for Coarse Concrete Aggregate. Gradation shall be ASTM C33 No. 57, No. 67, No. 357, or as follows:

Sieve Size Square Opening	Percent Passing
1"	95-100
3/4"	55-85
1/2"	25-50
No. 4	0-5

D. Earth Fill Material: Earth fill materials shall be as specified in Section 31 05 13 "Soils for Earthwork."

E. Flexible Base Course: Complying with Item 247 of the Texas Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, Type A, Grade 1 or 2, Flexible Base (Crushed Stone).

F. Hot Mix Asphalt Concrete (HMAC): Complying with Item 340 of the Texas Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

G. Controlled Low-Strength Material (Flowable Fill): Controlled low-strength material (flowable fill) shall be provided in accordance with Section 31 23 23.33 "Flowable Fill."

H. Modified Flowable Fill: Modified flowable backfill in areas of possible future excavation shall consist of a mixture of native soils or manufactured materials, cement and/or fly ash, air entraining material and water which produces a material with unconfined compressive strength of between 250 and 450 psi after 28 days. Any materials used shall be primarily granular, with a plasticity index less than 12 and with 100 percent passing a 3/4-inch sieve. The flowable mixture shall be mixed in a pub mill, concrete mixer, or transit mixer and shall have a minimum slump of 5 inches. The flowable mixture must be allowed to set prior to

the placement of any overlying materials. Modified flowable backfill in permanent areas such as abandoned pipe closures shall contain the same materials and have an unconfined compressive strength greater than 250 psi after 28 days.

I. Embedment Geotextile Material: Embedment geotextile material shall be Mirafi 180N polypropylene or approved equal.

J. The mixers used for mixing the soil cement backfill shall be designed and operated so that the soil cement discharged from the mixer is uniform in composition and consistency throughout each batch.

2.02 MIXES; SAND-CEMENT BACKFILL

A. A minimum sand and cement mixture of 27 parts sand and 2 parts cement will be required.

Fine Sand	1 Cubic Yard
Cement	1 Bag (Minimum)
Water	Optimum Moisture

B. Sand shall be free of any cohesive material and shall meet the following gradation and plasticity index requirements:

Sieve Size	Percent Passing
1”	100
1/2”	95-100
No. 40	80-100

C. PI and LL amounts.

Plasticity Index	10 Maximum
Liquid Limit	25 or less

3.00 EXECUTION

3.01 PREPARATION

A. Site:

1. Clear Site of logs, trees, roots, brush, tree trimmings and other objectionable materials and debris which are to be occupied by pipe trenches, and grub stumps. Designate material not salvaged for reuse as spoil and dispose of material in accordance with Paragraph 3.01.D.

2. Do not remove trees outside of the required working area unless their removal is authorized in writing by the Engineer and with the approval of the local governing authority. Adequately protect the trees left standing from permanent damage by construction operations. Standing trees may be trimmed where necessary to facilitate construction, but only with written authorization from the Engineer.

B. Dewatering:

1. Provide and maintain adequate dewatering equipment to remove and dispose of surface and ground water entering the excavations, trenches, or other parts of the Work. Keep each excavation dry during subgrade preparation and continually thereafter until the proposed pipe is installed. Maintain the proper procedures necessary to protect against damage to the proposed Work from hydrostatic pressure, flotation, or other water related causes.

2. Dewater excavations which extend down to or below ground water elevation by lowering and keeping the ground water level a minimum of 2 feet below the bottom of the excavation.

3. Divert surface water or otherwise prevent water from entering excavated areas to the extent possible without causing damage to adjacent property.

4. Provide and maintain any piping or conduit necessary to facilitate drainage. Do not alter area drainage patterns to the extent that adjacent property and landowners become threatened with localized flooding and/or water damage. Should such a situation occur, the Contractor shall be responsible for repairing the damage at no additional cost to the Owner.

C. Blasting: Blasting shall not be allowed in any instance.

D. Disposal of Spoil Material:

1. Suitable material from excavations which meets the requirements for pipe backfill material as indicated, except stripping excavation, may be reused. Designate the remaining excavated materials as spoil material and dispose of material off the Site in accordance with all applicable laws, ordinances, and codes. Contractor shall be responsible for the storage, transportation, and deposition of spoil material and shall be responsible for acquiring the necessary permits, and the payment of fees and duties at no additional cost to the Owner.

2. No burning of materials shall be permitted on the Site.

3.02 TRENCH EXCAVATION

A. General: The trenches shall be excavated to the alignment and depth indicated or as necessary for the proper installation of the pipe and appurtenances. Brace and dewater the trench if necessary so that the workmen may work therein safely and efficiently. Any specific requirement listed in Part 3.00, Execution, may be modified as necessary to meet OSHA requirements. However, if trench widths are wider than indicated, the Contractor shall be responsible for determining and furnishing the proper class of embedment and piping and for providing the modified installation with no additional compensation to the Contractor.

B. Trench Width: The trench widths shall be as shown on the Drawings.

C. Pipe Foundation:

1. Excavate the trench to the line and grade indicated and as directed by the Engineer. Grades shall be uniform between high points and low points to eliminate intermediate “highs and lows”.

2. For 12-inch diameter and smaller pipe, the trench shall be "rough cut" a minimum of 4 inches below the bottom of the pipe. For 14-inch and larger pipe, the trench shall be "rough cut" a minimum of 8 inches below the bottom of the pipe. The "rough cut" dimension shall be increased as necessary to provide a minimum clearance of 2 inches from the bottom of the trench to the bottom of the bells, flanges, valves, fittings, etc.

3. The entire foundation area in the bottom of all excavations shall be firm, stable material. Loose material shall be removed, leaving a clean, flat trench bottom, and material shall not be disturbed below required sub grade except as hereinafter described. If the subgrade is soft, spongy, disintegrated, or the character of the foundation materials is such that a proper foundation cannot be obtained at the elevation specified, direct the Owner's attention to such condition. Where directed by the Owner, deepen the excavation to a depth where a satisfactory foundation can be obtained. The sub grade shall then be brought back to the required grade with coarse gravel, thoroughly compacted to 75 percent relative density as determined by ASTM D4253 and D4254.

D. Correcting Faulty Grade: If the trench is excavated to a faulty grade (at a lower elevation than indicated), correct the faulty grade as specified below:

1. In uniform, stable, dry soils, correct the faulty grade with granular embedment material thoroughly compacted to 75 percent relative density as determined by ASTM D4253 and D4254.

2. In soft spongy disintegrated soils or where necessary to allow proper drainage, correct the faulty grade with coarse gravel compacted to 75 percent relative density as determined by ASTM D4253 and D4254.

3. Correct faulty grade at no additional cost to Owner.

E. Pipe Clearance in Rock: Remove ledge rock, rock fragments, or unyielding shale or marl to provide a clearance of at least 6 inches below the parts of the pipe, valves or fittings. Provide adequate clearance for properly jointing pipe laid in rock trenches at bell holes. Refill the excavation to grade with granular embedment material.

F. Bell Holes Required: Bell holes of ample dimension shall be dug in trenches at each joint of pipe to permit the jointing to be made properly, visually inspected, and so that the pipe will rest on the full length of the barrel.

G. Care of Surface Material for Reuse: Surface materials such as top soil in its natural state, suitable for reuse in restoring the excavated surface, shall be kept separate from the general excavation material. The top 12 inches of the trench backfill shall be considered topsoil. Save the topsoil to be used as backfill of the top 12 inches of the trench after pipelaying.

H. Manner of Piling Excavated Material: Place excavated material in accordance with Paragraph 1.05 so that Work is not endangered and so as not to interfere with public traffic.

I. Trenching by Machine or by Hand: The use of any suitable trench digging machinery is permitted except in places where operations of same will cause damage to existing structures above or below ground. Employ hand methods as necessary in those cases.

J. Open Trench: The Owner shall have the right to limit the amount of trench which may be opened or partially opened at any time in advance of the completed line; and also the amount of trench left not backfilled. Not more than 150 feet of trench shall be left open

unless otherwise permitted in writing by the Owner. Backfill and/or protect trenches as necessary to prevent injury to livestock, adjacent property, Owner's personnel, and the public.

3.03 BACKFILL

A. Time of Backfilling: Backfill operations shall immediately follow pipe jointing, joint coating application, and curing.

B. Braced and Sheeted Trenches: Remove sheeting and shoring as backfilling operations progress. Incorporate methods so that a good bond is obtained between the backfill material and the undisturbed trench walls.

C. Protection of Pipe During Backfilling Operations: Take the necessary precautions to protect the pipe during backfilling operations. Take care to prevent damage to the pipe or to the pipe coating, and repair any damaged pipe before it is backfilled. Backfill the trench in a method to prevent the deformation or other deflection of the cylindrical shape of the pipe by more than the allowable pipe deflection as specified elsewhere. Use methods such as stulling or ellipsing as necessary.

D. Concrete Cradle, Encasement or Concrete Arch: Where indicated, install the pipe in concrete cradle, encasement, or concrete arch. Take precautions to prevent pipe movement or deflection during construction.

E. Concrete Blocking: Place blocking to rest against firm undisturbed trench walls. The support area for each block shall be at least as great as that indicated in the Standard Details and shall be sufficient to withstand the thrust, including water hammer, which may develop. Each block shall rest on a firm undisturbed foundation of trench sides and bottom.

F. Aggregate Fill Bedding:

1. After the trench has been cut to the depths indicated, bring up the bedding layer to a point slightly above grade in maximum 4-inch lifts and uniformly compact to the density indicated. Form bell holes and scoop out a trough to grade so that the pipe is uniformly supported by the embedment material. Lay and joint the pipe. Bring up the embedment material in maximum 4-inch lifts on either side of the pipe to the elevation above the pipe shown on the plans. Uniformly compact the material as specified below. Water jetting shall not be permitted.

G. Compaction Requirements:

1. Compact earth fill and cohesive aggregate fill in maximum 4-inch lifts with pneumatic rollers or power hand tampers and make a minimum of eight passes.

2. Compact cohesionless aggregate fill in maximum 4-inch lifts with vibratory rollers or vibratory plate power hand compactors and make a minimum of eight passes.

3. The acceptability of the compaction equipment shall be based upon the results of a test section.

4. Compact earth fill and cohesive aggregate fill to a minimum of 95 percent of maximum dry density as determined by ASTM D698, Standard Proctor.

5. Compact earth fill Class 1 and 2 at a moisture content within minus 0 to plus 5 percentage points of the optimum moisture content. Compact the remaining classes of earth fill and cohesive aggregate fill at a moisture content within minus 2 to plus 5 percentage points of optimum moisture content. The moisture ranges listed above are minimum and maximum limits. A tighter moisture range within these limits may be required to consistently achieve the specified density.

6. Compact cohesionless aggregate fill on which it is not practical to control the density by "Proctor" methods to a minimum of 75 percent relative density as determined by ASTM D4253 and D4254, or at the discretion of the Engineer, by a field compaction mold method correlated to ASTM D4253 and D4254.

7. Compact cohesionless aggregate fill at a moisture content within a range that accommodates consistent placement and compaction to the minimum relative density specified above.

8. The Contractor will arrange and pay for density and moisture testing. The testing frequency and methods shall be as required by the Engineer. The cost of repeating failed tests shall be borne by the Contractor. The Engineer may waive testing requirements on cohesionless bedding where testing is not practical because of limited space between the pipe and trench walls, however, the minimum number of passes of the compaction equipment specified above shall be achieved.

H. Backfill Procedure for Public and Private Roads: Backfill material above the pipe zone for existing roads including City Roads, County Roads, paved or improved private roads, driveways, and any proposed roads as indicated shall consist of flexbase material compacted in 6-inch lifts to 95 percent Standard Proctor Density. Replace asphalt paved roads with same thickness HMAC as existing, but not less than 2 inches. Replace concrete roadways with 3000 psi concrete reinforced equal to or better than existing. Saw-cut asphalt roads prior to placement of HMAC. Cut concrete roads back to expose reinforcing prior to replacing concrete paving.

I. Surface Material Replacement:

1. The top 12 inches of the trench backfill shall be composed of the original surface material or topsoil excavated from the trench. Place the topsoil over the consolidated trench backfill material and neatly round over the trench to a sufficient height to allow settlement to grade after consolidation. Grade the surface as indicated. If final grade is not shown, grade surface to allow drainage in the same manner as existed prior to construction.

2. Top soil shall not contain clods larger than 2 inches or rocks larger than those adjacent to the trench in the undisturbed condition.

3.04 FINISHING

A. Finish the top portion of backfill beneath established sodded (lawn) areas with not less than 6 inches of topsoil corresponding to, or better than, that underlying adjoining sodded areas. Other areas shall be seeded as specified elsewhere.

B. Grade and rake areas smooth and even which do not receive any type of paved surface, to allow drainage to drain away from the structures and toward the roads and streets or the natural drainage course.

3.05 FIELD QUALITY CONTROL

A. Compact backfill and appropriate embedment material to a minimum of 95 percent of maximum density at a moisture content of 0 to 5 percent of optimum for backfill and at optimum for sand-cement embedment as determined by ASTM D698, Standard Proctor.

B. Make periodic tests of compaction for conformance with this Section by an approved testing laboratory selected and paid for by Contractor. Contractor shall pay for re-testing until acceptable test results are obtained.

3.06 CLEAN AND ADJUST

A. Remove surplus pipeline materials, tools, rubbish and temporary structures and leave the Site clean, to the satisfaction of the Owner. Grade the surface and re-establish drainage. Removal of rock and other excess excavated material and general leveling and grading of the Site shall be part of the bid price and no additional payment shall be made.

END OF SECTION

31 25 13.13 SEEDING FOR EROSION CONTROL

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to seed the slopes and other areas as specified. This specification includes seedbed fertilization, watering, mulching, and emulsifying or tacking the mulch and maintenance until final acceptance by the Owner.

1.02 QUALITY ASSURANCE

A. Soil Testing: Fertilizer requirements for each planting area and for significantly different soil types within planting areas, will be determined by a qualified laboratory such as the Texas A&M University - Agricultural Extension Service soil testing laboratory. Representative composite soil samples will be collected from the planting areas and submitted to an approved soil testing laboratory.

1.03 STANDARDS

A. The seed used on this project will conform to ITEM 164.2 Standard Specifications for Construction of Highways, Streets and Bridges, Texas Department of Transportation.

1.04 DELIVERY AND STORAGE

A. Deliver seed with each variety separately bagged.

1.05 OPTIONS

A. If dry mechanical methods are used, the fertilizer may be spread at the same time as the seed. After sowing, straw mulch will be mechanically spread over the seeded area.

B. When seed and fertilizer are to be distributed as a water slurry, apply the mixture within 30 minutes of mixing.

2.00 PRODUCTS

2.01 MATERIALS

A. Seed: From the previous season's crop, labeled in accordance with the Texas Seed Law.

1. Seed for Fall planting (temporary) shall be one or more of the following small grains as designated by the Engineer: Wheat, oats, rye, or barley.

2. Seed for spring planting (permanent) shall be Bermuda grass.

B. Fertilizer: Insert requirements.

C. Mulch:

1. Consisting of straw, wood-fiber, mulch nettings, wood chips or other suitable material approved by the Engineer and free of Johnson grass and other noxious weed seeds.

2. Straw mulch shall be oat, wheat or rice straw, prairie hay, Bermuda grass hay, or other hay harvested before seed production and approved by the Engineer. The straw mulch

will be kept dry and shall not be rotted or molded. A minimum of 50 percent by weight of the herbage making up the hay shall be 10 inches in length or longer.

D. Topsoil: As specified for Class 12 earth fill in Section 31 05 13 "Soils for Earthwork."

E. Herbicide: Contractor shall be responsible for using herbicides in a manner consistent with label requirements and precautions. Only registered herbicides having a minimal residual effect shall be used. Contractor shall strictly adhere to all Federal, State, and local laws governing herbicide usage.

3.00 EXECUTION

3.01 TOPSOIL PLACEMENT

A. Place topsoil as specified for Class 12 earth fill in Section 31 23 23.16 "Compacted Earth Fill [Landfills and Heavy Earthwork Projects, Excluding Dams]."

3.02 FALL PLANTING

A. Fall planting will be temporary only and will be required if construction is completed between May 15 and November 30. The fall planting is to be followed by a spring planting of perennial vegetation.

B. Seedbed Preparation: Use a one-way plow, tandem disk, bedder, or equipment which will accomplish similar results. Break or mix the surface of the soil with the tillage equipment. Additional tillage operations will be necessary if required so planting can be on a clean, firm seedbed. Chiseling will be necessary on areas which have been severely compacted.

C. Seeding:

1. Seeding will be required on disturbed or excavated areas and on new embankments of whatever nature unless requested otherwise by the Engineer.

2. Optimum fall planting dates are September 1 to November 30. Accomplish the seeding for fall planting within these dates unless approval to do otherwise is obtained from the Engineer. Planting rates when drilled or broadcast are as follows:

Seeding	lb./acre
Wheat	120 lb./acre
Oats	128 lb./acre
Rye	112 lb./acre
Barley	114 lb./acre

3.03 SPRING PLANTING

A. Follow procedures for spring planting if construction is completed between November 30 and May 15, or after a temporary fall planting has been made:

1. Seedbed Preparation: Seedbed preparation for Spring planting is the same as that stated in the Fall planting of temporary cover with one addition: Any temporary cover crop must be top killed using an approved contact herbicide or by mechanically undercutting the growing cover crop, leaving residues on or near the soil surface.

2. Mulching:

    a. Spread mulch material on the area to be planted if construction was completed too late for planting a temporary fall crop or if insufficient residues are produced by the fall planting. Mulch the planting areas to control soil erosion and seed loss by wind and water and to promote grass establishment. Apply Mulch hay at the rate of 2 tons per acre and spread uniformly so that about 25 percent of the ground surface is uniformly visible through the mulch.

    b. Anchor the mulch hay by treading into the soil with a straight disk type mulch tiller. Perform disking across the slope along contours. Other types of mulch such as wood cellulose fiber or cotton bur mulch may be used at recommended rates, if approved by the Engineer. Apply mulch in a manner that will not hinder emergence of seedlings.

3. Seeding:

    a. Plant Bermuda grass seed between March 1 and May 15. Sow the seed at the rate of 50 pounds of pure live seed (PLS) per acre, or more if required to obtain a complete stand of grass. The PLS content is determined by multiplying the seed package weight by the product of the percent purity and the percent germination, which are contained on the seed label.

    b. Accomplish seeding by mechanical means using either broadcasting or drilling type equipment to provide uniform distribution of the seed in the planting areas. Cover Bermuda grass seed by 1/4 to 1/2 inch of soil. If seed is drilled, the distance between drill rows shall not exceed 12 inches. Hydro seeding may be used to apply seed, fertilizer, and wood-fiber mulch with the approval of the Engineer.

3.04 MAINTENANCE

A. Irrigation: Supply the seeded areas with adequate moisture (3- to 4-inch penetration) at 10-day intervals, if needed, for seed germination and plant growth until acceptance by the Owner. Water the seed in a manner which will prevent erosion of the soil. Furnish all water to be used.

B. Repair: Repair washouts and other bare soil areas in a seeded area either by re-seeding, sprigging, or spot sodding, and perform maintenance as needed to establish grass in the area.

C. Weed Control:

    1. Control competitive weed growth during the establishment period by mowing and/or with herbicides. Chemical usage shall be in accordance with the current recommendations of the Texas Agricultural Experiment Station or local Soil Conservation Service Field Office Technical Guides. Strictly adhere to all Federal, State, and local laws governing herbicides.

    2. Weed control shall be the Contractor’s responsibility whether topsoil is from on-site or off-site sources and also for seeded areas which are specified not to receive topsoil.

3.05 SEEDING OF DISTURBED AREAS

A. Disturbed areas will require seeding as specified in this Section unless requested otherwise by the Engineer or shown otherwise on the drawings or in the specifications.

B. Any areas which are disturbed by the Contractor which are not shown on the drawings or specified to require disturbance including any approved areas not shown on the drawings, shall be considered as unauthorized disturbed areas. Any such areas shall be seeded as specified in this Section at the Contractor's expense and shall not be measured or paid under this Section.

3.06 FIELD QUALITY CONTROL; OBSERVATION AND ACCEPTANCE

A. Observation: Upon completion of the site preparation, mulching, fertilizing, seeding, and maintenance of seeded areas, the Engineer will observe the seeded areas periodically to determine the establishment success. The Engineer will consider soil coverage, purity of the grass stand, and maturity of the plants.

B. Establishment of Stand and Acceptance:

1. The Engineer will determine that a grassed area is established upon fulfillment of the following conditions:

2. The permanent grass stand uniformly covers the planting area, with no exposed soil areas more than 36 inches across in any dimension.

3. The permanent grass stand is free of over-topping weed species which would compete for sunlight, moisture, and nutrients. In addition, no area of pure weed species greater than 36 inches across in any dimension shall occur within a permanent grass stand.

4. The majority of the grass plants in a stand shall have a well-established root system to survive if irrigation is discontinued.

5. Establish the permanent grass stand before October 1 to preclude having to perform a temporary Fall seeding. In the event a fall seeding must be performed, follow-up the temporary seeding with a permanent seeding as specified. Upon final acceptance of the work under this contract, the Owner will assume the responsibility of maintaining the grassed areas.

END OF SECTION

APPENDIX A

A1.00 MEASUREMENT AND PAYMENT

A1.01 MEASUREMENT

A. Areas seeded shall be measured to nearest 0.1 acre by a survey performed by the Contractor. The Contractor shall cooperate with the Engineer to determine the adequacy and accuracy of the survey.

A1.02 PAYMENT

A. Payment for seeding will be made on the basis of the unit price bid per acre for "Seeding for Erosion Control." A maximum of 50 percent completion of any area will be approved for completion of seedbed preparation, mulching, and temporary and permanent seeding. The remaining percentage will be approved after stand establishment.

END OF APPENDIX A

31 32 13.19 LIME SOIL STABILIZATION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to treat subgrade by pulverizing, adding lime, mixing, and compacting the mixed material to the required density conforming with the lines, grades, and typical section(s) as indicated on the Drawings.

1.02 QUALITY ASSURANCE; AMOUNT OF LIME

A. The minimum percent of lime to be used shall be as indicated on the Drawings, and within this Section, for the depth of subgrade treatment specified and shall be verified during construction according to Paragraph 1.03. In no case shall less than 6 percent by weight be applied.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Pre-Lime Treatment Submittals:

a. The following items shall be furnished to the Engineer at least 30 days prior to beginning lime treatment:

1). The source and supplier of lime.

2). Construction equipment and methods, expected production rates, and planned sequence.

b. The following items shall be furnished to the Engineer prior to beginning lime treatment within any section of the roadway. Submittals shall be supplied in a timely fashion suitable to the sequencing and scheduling of construction activities. Lime treatment will not commence without submittal of these items and approval by the Engineer.

1). Verification of lime application rate using Tex-121-E, Part III: One test per 1000 linear feet of exposed subgrade; minimum of three tests. Tests shall be performed on samples collected within the subgrade soils to be treated, alternating between traffic lanes, when possible.

2). Sulfate content using Tex-145-E: One test per 800 linear feet of exposed subgrade; minimum of three tests. Tests shall be performed on samples collected within the subgrade soils to be treated, alternating between traffic lanes, when possible.

2. During Lime Treatment Submittals: The following items shall be furnished to the Engineer at the end of each day:

a. Certified truck weight tickets of lime delivered to the Site.

b. A summary of the amount of lime used and areas treated, including treatment stage – initial mixing, final mixing, mellowing, compacted, and completed.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C25	Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C110	Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D6276	Standard Test Method for Using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

2. Texas Department of Transportation (TxDOT) Standards:

Tex-101-E	Test Procedure for Preparing Soil and Flexible Base Materials for Testing
Tex-113-E	Test Procedure for Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials
Tex-114-E	Test Procedure for Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material
Tex-115-E	Test Procedure for Field Method for Determining In-Place Density of Soils and Base Materials
Tex-121-E	Test Procedure for Soil-Lime Testing
Tex-145-E	Test Procedure for Sulfate Content in Soils – Colorimetric Method

2.00 PRODUCTS

2.01 MATERIALS; HYDRATED LIME

A. Type A, Hydrated Lime:

1. Hydrated Lime shall consist of a dry powder obtained by treating quicklime with enough water to satisfy its chemical affinity for water under the conditions of its hydration. This material is to consist essentially of calcium hydroxide or a mixture of calcium hydroxide and a small allowable percentage of calcium oxide, magnesium oxide, and magnesium hydroxide.

2. Calcium and Magnesium Oxides: Min. 90 percent.

3. Carbon Dioxide:

a. If sampled at place of manufacture: Max. 5 percent.

b. If sampled at any other place: Max. 7 percent.

4. Non-Hydrated Lime Content, percent by weight:
    a. CaO: Max. 5 percent.
5. The percent by weight of residue retained shall conform to the following requirements, as determined by procedures given in ASTM C110:
    a. Residue retained on a No. 6 (3360-micron) sieve: None.
    b. Residue retained on a No. 10 (2000-micron) sieve: Max. 1.0 percent.
    c. Residue retained on a No. 30 (590-micron) sieve: Max. 2.5 percent.
6. Specifications for Type A apply specifically to the normal hydrate of lime made from "high-calcium" type limestone. Hydrated lime for stabilization purposes shall be, as provided in the governing specifications, mixed with water to form a slurry.

B. Type B, Commercial Lime Slurry:

1. Type B, Commercial Lime Slurry, shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity and/or nature injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of "solids content," shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.
2. Chemical Composition: The "solids content" of the lime slurry shall consist of a minimum of 90 percent by weight of calcium and magnesium oxides.
3. Residue: The percent by weight of residue retained in the "solids content" of lime slurry shall conform to the following requirements:
    a. Residue retained on No. 6 (3360-micron) sieve: Max. 0.0 percent.
    b. Residue retained on No. 10 (2000-micron) sieve: Max. 1.0 percent.
    c. Residue retained on No. 30 (590-micron) sieve: Max. 2.5 percent.
    d. Type B, Commercial Lime Slurry, shall conform to one of the following two grades:
        1). Grade 1: The "Dry Solids Content" shall be at least 31 percent by weight of the slurry.
        2). Grade 2: The "Dry Solids Content" shall be at least 35 percent by weight of the slurry.
4. When Type B, Commercial Lime Slurry, is specified, the Contractor shall select, prior to construction, the grade to be used and shall notify the Engineer in writing before changing from one grade to another.

2.02 MIXES; LIME SLURRY

A. The approximate mix for lime slurry is 1 ton of lime to 533 gallons of water which gives a 31 percent lime solution, and 1 ton of lime to 445 gallons of water which gives a 35 percent solution.

2.03 EQUIPMENT

A. Machinery, tools, and equipment necessary for proper prosecution of the Work shall be on the Site prior to the beginning of construction operations. Use slurry tanks equipped with agitation devices to slurry hydrated lime on the Project. The Engineer may approve other methods of slurry application.

B. Provide equipment to spread lime evenly across the area to be treated.

C. Machinery, tools, and equipment used on the Project shall be maintained in a satisfactory and workmanlike manner.

3.00 EXECUTION

3.01 PREPARATION

A. It is a primary requirement of this Section to secure a completed course of treated material containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. Regulate the sequence of Work, use the proper amount of lime, maintain the Work, and rework the courses as necessary to meet these requirements.

B. Prior to beginning any lime treatment, construct and shape the roadbed to conform to the typical sections, lines, and grades as indicated on the Drawings or as established by the Engineer and perform soil-lime proportioning and sulfate content testing per Paragraph 1.03.

1. Soil-lime proportioning and sulfate content testing shall be submitted and approved by the Engineer prior to beginning lime treatment.

2. For subgrades containing sulfate contents greater than 3000 parts per million (ppm) and less than 7000 ppm, additional treatment steps are required as specified within subsequent paragraphs of this Section.

3. Treatment of subgrade soils containing sulfate contents greater than 7000 ppm with calcium-based additives, such as lime or cement, is not permitted. Unless otherwise directed by the Engineer, subgrade areas with sulfates greater than 7000 ppm shall be undercut a minimum depth of 1 foot below the layer to be treated and replaced with material possessing a soluble sulfate content of less than 3000 ppm. Soils possessing a sulfate concentration greater than 7000 ppm shall not be allowed within 1 foot vertically or horizontally of a lime treated layer, whether the roadway is in cut or fill.

4. Any excavated sulfate-laden material with a sulfate content greater than 7000 ppm will be acceptable for use in roadway fill areas, but shall not be used within areas of the subgrade to be treated with calcium-based additives.

C. Proof roll the roadbed prior to pulverizing or scarifying the existing subgrade to be treated, as directed in Paragraph 3.02.A.1, and correct soft spots as needed and directed.

3.02 TREATMENT OF SUBGRADE

A. Treatment:

1. Use a cutting or pulverizing machine that will cut and pulverize the subgrade material accurately and simultaneously to the secondary grade. This method will be permitted only where a machine is provided which will ensure that the material is cut uniformly to the proper depth and which has cutters that will place the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth. Pulverize or scarify existing material after shaping so that 100 percent passes a 2-inch sieve.

2. Initial Hydration: For subgrades containing sulfate contents greater than 3000 ppm and less than 7000 ppm, an initial hydration period of 72 hours is required prior to adding lime. Apply water to the pulverized subgrade until the optimum moisture content as determined by Tex-113-E is achieved, and maintain the subgrade at or above optimum moisture for the duration of the specified 72-hour hydration period.

B. Application:

1. Apply lime only when the air temperature is at least 35 F and rising or is at least 40 F.

2. Spread lime slurry only on that area on which the mixing operation can be completed the same working day.

3. Accomplish the application and mixing of lime with the materials by the method hereinafter described as “Slurry Placing,” unless otherwise approved by the Engineer.

C. Slurry Placing:

1. Method:

a. Apply Lime Slurry, with a lime percentage not less than that applicable for the grade used. The distribution of lime at the rate shown on the Drawings, or as adjusted and directed by the Engineer resulting from the soil-lime proportioning test requirements in Paragraph 1.03, shall be attained by successive passes over a measured surface of roadway until the proper moisture and specified lime content have been achieved. The distributor truck shall be equipped with an agitator which keeps the lime and water in a uniform mixture.

b. It is anticipated that the rate of application of lime shall not be less than 4.5 pounds of lime per square yard per inch of depth of compacted subgrade, or a total of 27 pounds per square yard for a 6-inch depth of treated compacted subgrade. This is approximately a 6 percent mixture of lime by typical dry weight of the subgrade material, which may vary according to the laboratory tests. Actual application rates shall be determined per Paragraph 1.03, but in no case shall less than 6 percent by weight be applied.

2. Mixing:

a. Initial Mixing: Begin mixing within 6 hours of the application of lime.

1). Thoroughly mix the material and lime by approved road mixers or other approved equipment, and continue mixing until a homogeneous, friable mixture

of material and lime is obtained, free from clods or lumps such that 100 percent passes a 1-1/2-inch sieve.

2). Seal the lime treated subgrade with a pneumatic roller, and allow the lime treated subgrade to mellow according to the following time periods based on sulfate concentrations:

a). 1 to 4 days as directed by the Engineer for subgrades containing sulfate contents less than 3000 ppm.

b). 7 days measured from day one of the application for subgrades containing sulfate contents greater than 3000 ppm and less than 7000 ppm.

3). Maintain the lime treated subgrade at the optimum moisture content to plus 4 percentage points as determined from Tex-113-E during the mellowing period.

b. Final Mixing: After the required mellowing period, uniformly mix the material by approved methods. If the soil binder-lime mixture contains clods, reduce the clods in size by raking, blading, discing, harrowing, scarifying, or the use of other approved pulverization methods so that when all non-slaking aggregates obtained on the No. 4 sieve are removed, the remainder of the material meets the following requirements when tested dry by laboratory sieves:

1). Minimum passing 1-inch sieve: 100 percent.

2). Minimum passing No. 4 sieve: 60 percent.

3. During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6 hours or more, or to excessive loss due to washing or blowing, will not be accepted for payment.

D. Compaction:

1. Begin compaction of the mixture immediately after final mixing and in no case later than 3 calendar days after final mixing. Aerate or sprinkle the material as necessary to provide optimum moisture. Begin compaction at the bottom of the mixed, lime treated subgrade and continue until the entire depth of the mixture is uniformly compacted as indicated or specified by the Engineer; multiple lifts are permitted. The compacted mixture shall have a uniform density of not less than 95 percent of the maximum dry density at a moisture content between optimum moisture and 4 percent above optimum moisture as determined by Tex-113-E. After each section is completed, such tests as are necessary shall be made by the laboratory as required by the Engineer. If any portion fails to meet the density or the depth specified, rework that portion as necessary to obtain the specified density and depth of lime treatment required.

2. When a section is reworked due to a failed density or depth check within 72 hours after completion of compaction, rework the section to provide the required density. When a section is reworked more than 72 hours after completion of compaction, add additional lime at 25 percent of the initial lime requirement. Reworking includes loosening, adding material or removing unacceptable material (if necessary), mixing, compacting, and finishing. Determine a new maximum density of the reworked material and compact the mixture according to the density and moisture specified in Paragraph 3.02.D.1. The cost of reworking shall be considered subsidiary to this item.

E. Finishing, Curing, and Preparation for Surfacing:

1. After the mixture has been adequately compacted, shape the surface to the required line, grades, and cross-sections, and then thoroughly roll with a pneumatic or other suitable roller sufficiently light to prevent hairline-cracking. The completed section shall then be moist-cured for a minimum of 2 to 7 days before further courses of material or pavement are added or any traffic permitted. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to light traffic 2 days after compaction. If the completed section has not been covered by other courses of material or pavement in 7 days, seal the completed section by an application of AC-20 asphalt at the rate of 0.10 gallons per square yard.

2. The Engineer shall be informed of any subgrade exhibiting heave and will have 5 days to determine which areas will require removal and additional treatment or other appropriate remediation. When a section is reworked due to heave, provide additional lime at 25 percent of the initial lime requirement. Reworking includes loosening, adding material or removing unacceptable material (areas exhibiting heave) if necessary, mixing, compacting, and finishing. Determine a new maximum density of the reworked material and compact the mixture according to the density and moisture specified in Paragraph 3.02.D.1. The intent of the reworking in areas of heave is to allow remediation of the subgrade prior to paving.

3.03 MAINTENANCE

A. Maintain the completed soil-lime base within the limits of the Contract, in good condition, satisfactory to the Engineer as to grade, crown, and cross-section until such time as the surface course is constructed. At the Contractor's expense, immediately repair irregularities or other defects that occur. Repairs are to be made in a manner to ensure restoration of a uniform surface and durability of the portion repaired.

END OF SECTION

APPENDIX A

A1.00 MEASUREMENT AND PAYMENT

A1.01 PAYMENT

A. The Work performed and materials furnished in accordance with this item and measured as provided within this Section will be paid as follows:

1. Lime:

a. Lime will be paid for at the unit price bid for lime as follows:

1). Type A, Hydrated Lime.

2). Type B, Commercial Lime Slurry.

2. Lime Treatment: Lime treatment will be paid for at the unit price bid for TREATMENT OF SUBGRADE for the depth specified. No payment will be made for thickness or width exceeding that shown on the Drawings. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying lime, compacting, finishing, curing, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals. Removing heaved sections, treating and regrading under Paragraph 3.02.E.2 will be considered extra work and will be paid by the ton at the unit price bid for hydrated lime and by the square yard at the unit price bid for lime treatment.

3. Undercutting: Required undercutting in a cut area for soils that have a soluble sulfate level greater than 7000 ppm under Paragraph 3.01.B.3, or for areas of lime treatment that have heaved and need to be removed, the undercutting will be paid at the price bid for EXCAVATION; replacement of more suitable material will be paid at the price bid for FILL; and further treatment will be paid as LIME TREATMENT.

END OF APPENDIX A

32 11 23 AGGREGATE BASE COURSES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to perform operations in connection with the construction of flexible base. Flexible base shall consist of a foundation for a road surface or for other courses. Construct the flexible base foundation course as specified herein in one or more courses in conformance with the typical sections, lines, and grades indicated in the plans.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Submittal Procedures” and shall include:

1. Sieve analysis liquid and plastic limits and plasticity index of the material to be used as record data.

1.03 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C131	Test Methods for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D2217	Practice of Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.04 DELIVERY AND STORAGE

A. Deliver materials in approved vehicles. Stockpile materials in locations that are acceptable to the Owner’s Representative and shape to drain.

2.00 PRODUCTS

2.01 MATERIALS

A. Base; General:

1. The materials shall be crushed or uncrushed as necessary to meet the requirements hereinafter specified, and shall consist of durable coarse aggregate particles mixed with approved binding materials. The material shall be approved by the Owner’s Representative.

2. Should the Contractor elect to produce the material from local pits, secure the material from the sources approved by the Owner’s Representative. The pits as utilized shall be

opened in such a manner to immediately expose the vertical faces of the various strata of acceptable material and unless otherwise directed, the material shall be secured in successive vertical cuts extending through the exposed strata, in order that a uniform mixed material will be secured.

B. Types:

1. Unless the type of material to be used is specified on the plans, the Contractor may use any one of the following types, provided the material proposed for use by the Contractor meets the requirements set forth in the specification test limits tabulation.

2. Type A: Crushed Limestone:

   a. The material shall be obtained from approved sources, shall be crushed, and shall consist of durable particles of limestone mixed with approved binding materials. The material shall be approved by the Owner's Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size	Percent Passing
1-3/4"	100
3/8"	40-80
No. 4	25-60
No. 40	15-35

   b. The material when tested under "The Wet Ball Method for Determining the Disintegration of Flexible Base Materials" shall not develop more than 50 percent soil binder.

   c. Materials passing the No. 40 sieve shall be known as "Binder" and shall meet the following requirements:

      1). The liquid limit shall not exceed 40 when tested in accordance with ASTM D423.

      2). The plastic limit shall be determined by testing in accordance with ASTM D424.

      3). The plasticity index shall not exceed 12 nor be less than 4 when calculated in accordance with ASTM D424.

      4). The preparation of samples for testing according to ASTM D4318 and shall be in accordance with the requirements of ASTM D2217.

      5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 45 percent when tested in accordance with ASTM C131.

3. Type B: Processed Gravel:

   a. The materials shall be obtained from approved sources and shall consist of durable particles of gravel mixed with approved binding materials. The material shall be approved by the Owner's Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size Square Opening	Percent Passing
1-3/4”	40-80
No. 4	40-80
No. 4	25-60
No. 40	15-35

b. Materials passing the No. 4 sieve shall be known as “Binder.” The portion of material passing the No. 40 sieve shall be known as “Soil Binder” and shall meet the following requirements:

1). The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318.

2). The plastic limit shall be determined by testing in accordance with ASTM D4318.

3). The plasticity index shall not exceed 10 when calculated in accordance with ASTM D4318.

4). The preparation of samples for testing according to ASTM D4318 and shall be in accordance with the requirements of ASTM D2217.

5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 55 percent when tested in accordance with ASTM C131.

4. Type C: Bank-Run Gravel:

a. The materials shall be obtained from approved sources and shall consist of durable particles of gravel mixed with approved binding materials. The material shall be free from thin or elongated pieces, lumps of clay, soil, loam, or vegetable matter. The material shall be approved by the Owner’s Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size	Percent Passing
1-3/4”	95-100
No. 4	25-70
No. 40	15-35

b. Materials passing the No. 4 sieve shall be known as “Binder.” The portion of material passing the No. 40 sieve shall be known as “Soil Binder” and shall meet the following requirements:

1). The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318.

2). The plastic limit shall be determined by testing in accordance with ASTM D4318.

3). The plasticity index shall not exceed 10 when calculated in accordance with ASTM D4318.

4). The preparation of samples for testing according to ASTM D4318 and shall be in accordance with the requirements of ASTM D2217.

5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 55 percent when tested in accordance with ASTM C131.

3.00 EXECUTION

3.01 PREPARATION

A. In conformance with the typical sections, lines, and grades indicated, excavate and shape the road bed. Remove unstable or otherwise objectionable material from the subgrade and replace with approved material. Fill holes, ruts, and depressions with approved material. Sprinkle the subgrade, if necessary, and reshape and roll to the extent directed in order to place the subgrade in an acceptable condition to receive the base material. The surface of the subgrade shall be smooth and conform to line, grade, and typical sections. Prepare sufficient subgrade in advance to insure satisfactory prosecution of the work.

B. Utilize material excavated in the preparation of the subgrade in the construction of adjacent shoulders and slopes or otherwise disposed of as directed. Secure any additional material required for the completion of the shoulders and slopes from sources indicated or designated by the Owner's Representative.

C. Immediately before placing the base course material, check the subgrade for conformance with the grade and typical sections indicated. The surface of the subgrade shall not show deviation in excess of 1/4 inch in 5 feet in cross-section, nor 1/2 inch in 16 inches longitudinally.

3.02 PLACEMENT

A. Number of Courses: Where the base course exceeds 6 inches in thickness, construct the base course in two or more courses of equal thickness as indicated on the typical section.

B. Placing Types A, B, and C: Spread and shape the material deposited on the subgrade the same day. Move the material at least once from the original position in which it is deposited. In the event of inclement weather or other unforeseen circumstances which render impractical the spreading of the material during the first 24 hour period, scarify and spread the material as directed by the Owner's Representative. Sprinkle the material, if directed, and then blade, drag, and shape to conform to the typical section as indicated. Correct or replace and remove areas and "nests" of segregated course or fine material with well graded material as directed by the Owner's Representative. If additional binder is considered desirable or necessary after the material is spread and shaped, furnish and apply material in the amount directed by the Owner's Representative. Carefully incorporate such binder with the material in place by scarifying, harrowing, brooming, or by other approved methods.

C. First Course (Types A, B, and C): Sprinkle the course as necessary and compact to the extent necessary to provide not less than the percent density as hereinafter specified under "Density." In addition to the requirements specified for density, compact the full depth of the flexible base to the extent necessary to remain firm and stable under construction equipment. After each section and course of flexible base is complete, the independent testing laboratory shall make tests of the material. If the material fails to meet the density

requirements, rework the material as necessary to meet the requirements. Throughout this entire operation, maintain the shape of the course by blading, and smooth the surface upon completion in conformity with the typical sections, lines, and grades indicated. On the surface of which pavement is to be placed, correct any deviation in excess of 1/4 inch in cross-section and in a length of 16 inches measured longitudinally by loosening, adding, or removing material, reshaping, and re-compacting by sprinkling and rolling. Immediately correct irregularities, depressions, or weak spots which develop by scarifying the areas affected, adding suitable material as necessary, reshaping, and re-compacting by sprinkling and rolling. Should the base course, due to any reason or cause, lose required stability, density, and/or finish before the surfacing is complete, re-compact and refinish the base course at the Contractor's sole expense.

D. Succeeding Courses (Types A, B, and C): Use the same construction methods as prescribed for the first course. Prior to placing the surfacing on the completed base, "dry cure" the base to the extent directed by the Owner's Representative.

E. Density: The density of the flexible base material shall not be less than 95 percent maximum dry density as determined by ASTM D698. Perform testing of densities of compacted base in accordance with a method approved by the Owner's Representative.

F. Curb and Gutter: Place and compact paving types with flexible base under the curb and gutter at the same time and in the same operation as the flexible base under the pavement. Place the flexible base in 6-inch maximum courses. Place and compact the first course under both the curb and gutter and the pavement.

END OF SECTION

32 91 13 SOIL PREPARATION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to place topsoil, free from rock and foreign material in areas designated to receive sodding or seeding.

2.00 PRODUCTS

2.01 TOPSOIL

A. General: The topsoil shall be fertile loam, easily cultivated and free from objectionable material, and shall have a relatively high erosion resistance and be readily able to support the growth of the planting, seeding, or sodding specified on the plans.

B. Sources:

1. The topsoil may be obtained from the right-of-way at sites of proposed excavation, or it may be obtained from sources outside the right-of-way, secured by the Contractor, and meeting the approval of the Engineer.

2. Topsoil required in addition to salvaged topsoil from the project shall be secured from approved off-site borrow sources. Excavated material from construction which is suitable for topsoil shall be salvaged and used before any topsoil is obtained from borrow source.

3.00 EXECUTION

3.01 INSTALLATION

A. Stockpile topsoil material at locations approved by the Owner's Representative. Remove any trash, wood, brush, stumps or other objectionable materials prior to placement. The source and stockpile areas shall be kept drained and in a neat and presentable condition. Place and spread topsoil to a uniform depth to provide 6-inch compacted depth, while maintaining drainage in areas to be seeded or sodded.

END OF SECTION

32 91 19.13 TOPSOIL PLACEMENT AND GRADING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to place topsoil, free from rock and foreign material in areas designated to receive sodding or seeding.

2.00 PRODUCTS

2.01 TOPSOIL

A. General: The topsoil shall be fertile loam, easily cultivated and free from objectionable material, and shall have a relatively high erosion resistance and be readily able to support the growth of the planting, seeding, or sodding specified on the plans.

B. Sources:

1. The topsoil may be obtained from the right-of-way at sites of proposed excavation, or it may be obtained from sources outside the right-of-way, secured by the Contractor, and meeting the approval of the Engineer.

2. Topsoil required in addition to salvaged topsoil from the project shall be secured from approved off-site borrow sources. Excavated material from construction which is suitable for topsoil shall be salvaged and used before any topsoil is obtained from borrow source.

3.00 EXECUTION

3.01 INSTALLATION

A. Stockpile topsoil material at locations approved by the Owner's Representative. Remove any trash, wood, brush, stumps or other objectionable materials prior to placement. The source and stockpile areas shall be kept drained and in a neat and presentable condition. Place and spread topsoil to a uniform depth to provide 6-inch compacted depth, while maintaining drainage in areas to be seeded or sodded.

END OF SECTION

32 92 13 HYDRO-MULCHING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, material, equipment and incidentals necessary to prepare the ground, furnish and install fertilizer and hydro-mulching seed or a mixture of seed of the kind specified in areas disturbed by the construction operations.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Submittal Procedures” and shall include:

1. Texas Testing Seed Label.
2. Specification of fertilizer to be used.

1.03 STANDARDS

A. The applicable provision of the following standard shall apply as if written here in its entirety:

1. Texas Seed Law.

1.04 GUARANTEES

A. The Contractor shall fertilize and reseed any area which fails to survive for a period of 1 year from the date the project is accepted by the Owner.

2.00 PRODUCTS

2.01 MATERIALS

A. General: Seed used must carry a Texas Testing Seed label showing purity and germination, name, type of seed, and that the seed meets all requirements of the Texas Seed Law. Seed furnished shall be of the previous season’s crop and the date of analysis shown on each tag shall be within 9 months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers.

B. Seed: The specified seed shall equal or exceed the following percentages of purity and germination:

Common Name	Purity	Germination
Common Bermuda Grass	95%	90%
Gulf Coast Annual Rye	95%	90%

C. Mulch: The mulch shall be natural cellulose fiber mulch produced from grinding clean, whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7 percent. The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with

fertilizers and other additives. The mulch shall be such that, when applied, the material shall form a strong, moisture-retaining mat without the need of an asphalt binder.

D. Fertilizer: Pelleted or granulated type fertilizer of the composition for the season of the year at which applied shall be used:

1. Early season (April 1-June 1) 21-0-0.
2. Normal season (June 1-Sept 1) 10-10-5.
3. Late season (Sept 1-Nov 1) 6-12-12.

3.00 EXECUTION

3.01 PREPARATION

A. After the areas disturbed by construction operations have been backfilled and completed to the original pre-construction lines and grades shown on the plans and as provided for in other items of this contract, perform hydro-mulch seeding in accordance with the requirements hereinafter described.

3.02 INSTALLATION

A. Cultivation: Cultivate areas to be seeded to a depth of at least 4 inches. Cultivate the seedbed sufficiently to reduce the soil to a state of good tilth when the soil particles on the surface are small enough and lie closely enough together to prevent the seed from being covered too deep for optimum germination. Cultivation of seedbed will not be required in loose sand where depth of sand is 4 inches or more. Maintain the cross-section previously established throughout the process of cultivation and any necessary reshaping shall be done prior to any planting of seed.

B. Planting Season and Application Rates: Perform planting between the dates specified for each type except when specifically authorized in writing. The seeds planted per acre shall be of the type specified with the mixture, rate, and planting dates as follows:

1. Common Bermuda Grass - hulled, 20 pounds per acre - February through August or a combination of.
2. Common Bermuda Grass - unhulled, 15 pounds per acre and Gulf Coast Annual Rye - unhulled, 15 pounds per acre - August through February.
3. Apply fertilizer uniformly at the average rate of 400 pounds per acre.

C. Hydro-Mulch (Cellulose Fiber) Seeding: Uniformly distribute the fertilizer, seed or seed mixture, in the quantity specified over the areas to be seeded. Mechanical equipment shall be such that all varieties of seed as well as fertilizer may be distributed at the same time, provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water-slurry, apply the mixture to that area to be seeded within 30 minutes after all components are placed in the equipment. Upon completion of planting the seed, spread cellulose fiber mulch uniformly over the area at the following rates:

1. Sandy soils with 3:1 slope or less: min. 2000 lb./acre.
2. Sandy soils with greater than 3:1 slope: min. 2300 lb./acre.

3. Clay soils with 3:1 slope or less: min. 2500 lb./acre.
4. Clay soils with greater than 3:1 slope: min. 3000 lb./acre.
5. The rates are given in dry weight of mulch per acre. A mulching machine, approved by the Owner's Representative, shall be equipped to eject the thoroughly wet mulch material at a uniform rate to provide the mulch coverage specified.

D. Maintenance: Water the planted area at such times as necessary for a period of 1 year after final acceptance of the project by the Owner. Fertilize and reseed any area which fails to survive for a period of 1 year from the date the project is accepted by the Owner.

END OF SECTION

33 01 01 PLANT PIPING - GENERAL

1.00 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install, complete, the plant piping specified herein and as further specified in the Detail Piping Specifications hereinafter.

B. Material provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance and manufacturer's service.

C. Pipe testing shall be as specified in Section 01 40 00 – Quality Requirements

1.02 SUBMITTALS

A. In addition to the submittal requirements in Section 01 33 00 “Submittal Procedures”, the following information shall be provided:

1. A specific selection of pipe material and joint type for each pipeline.

2. Double-line drawings of each piping support system to the scale stated on the Contract drawings, locating each support and hanger, identifying the type by catalog number or shop drawing detail number, and showing anchor locations and identifying them by shop drawing detail number.

3. Detail installation drawings, catalog information, and complete component selection list for metal framing pipe support system in the buildings, pipe galleries, trenches, and other locations employing metal framing pipe support systems.

4. Pipe leak test reports.

5. Verifiable Certificate of Compliance with the NSF 61 Standard for all applicable pipe and fittings.

1.03 PIPE IDENTIFICATION

A. All exposed piping shall be labeled as specified in Section 40 05 53 “Identification for Process Piping and Equipment”.

2.00 PRODUCTS

2.01 WATER SOURCE

A. Water for testing under this Section will be provided by the Owner.

B. The Contractor shall make complete and satisfactory arrangements with the Owner prior to obtaining water for testing purposes. It shall be the responsibility of the Contractor to provide all equipment necessary to transport the water from the source to the structure to be tested.

3.00 EXECUTION

3.01 PIPE PREPARATION AND HANDLING

A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

B. Use proper equipment, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

3.02 INSTALLATION OF BURIED PIPING

A. Removal of Water: Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench during the process of pipe laying. The trench shall be kept dry until the pipe laying and jointing are completed. Prevent Trench Water and Animals from Entering Pipe:

1. During installation, keep the interior of all pipe, fittings, and other accessories as free as possible from dirt and foreign matter at all times.

2. When the pipe laying is not in progress, including the noon hours, the open ends of pipe shall be sealed by a plug or cap to prevent trench water, animals, or foreign material from entering the pipe. If water has accumulated in the trench, the seal shall remain in place until the trench water has been removed to such an extent that it will not enter the pipe.

3.03 INSTALLATION OF EXPOSED PIPING

A. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.

B. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle vertical centerline of pipes.

C. Unions, mechanical coupling or flanged coupling adaptors shall be installed where required for piping or equipment installation, even though they are not shown on the plans. All mechanical couplings and flanged coupling adaptors shall be anchored with joint harnessed assemblies.

D. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

E. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

F. Where valve handwheels or chainwheels are shown, valve orientation shall also be as shown on drawings. Where valve handwheels or chainwheels are not shown, valves shall be orientated to permit easy access to the handwheels or chainwheels, and to avoid interferences.

3.04 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and fillings, gravel, cleaning rags, etc., within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.05 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Owner's Representative. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at a lower velocity. Accumulated debris shall be removed through drains 2-inch and larger or by dropping spools and valves.

B. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

C. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

END OF SECTION

33 01 02 PIPING SPECIALTIES

1.00 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor and materials required and installed complete and ready for operation, all appurtenances as shown on the Drawings or as specified.

B. The appurtenances shall include, but not be limited to the following: (Note: All items listed below may not be required in this Contract).

1. Mechanical Type Wall Seals
2. Service Clamps
3. Dielectric Insulating Gasket Kits for Flanges
4. Harnessing and Restraint
5. Sleeve Couplings (Dresser type)
6. Flanged Coupling Adapters
7. Quick Connect Couplings
8. Expansion/Vibration Joints (Fittings)
9. Modular Mechanical Expanding Rubber Seals
10. Pipe Supports
11. Floor Drains
12. Wall and Floor Fittings
13. Gauges and Accessories
14. Valve Operators
15. Strainers
16. Corporation Stops
17. Flexible Chemical Carrier Tubing
18. Insulation for Process Piping
19. Appurtenances and Miscellaneous Items
20. Pipe Coupling
21. Copper Pipe and Fittings
22. Fiberglass Reinforced Pipe and Fittings
23. Emergency Eyewash/Shower

1.02 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 00 “Submittal Procedures”. They shall show as a minimum all details and materials of construction and dimensions.

B. Submit operating and maintenance instruction in compliance with Section 01 78 23 “Operations and Maintenance Data”.

1.03 REFERENCE STANDARDS

A. American National Standards Institute (ANSI): ANSI B2.1.

B. American Society for Testing and Materials (ASTM):

1. ASTM A 126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A 183 - Specification for Carbon Steel Track Bolts and Nuts.
3. ASTM A 278 - Specification for Gray Iron Castings for Pressure Containing Parts for Temperatures Up to 650 degrees F.
4. ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings.
5. ASTM B 88 - Specification for Seamless Copper Water Tube.
6. ASTM A 536 - Specification for Ductile Iron Castings.

C. American Water Works Association (AWWA): AWWA C 606 - Grooved and Shouldered Joints.

D. Federal Specifications (F.S.): MIL-C-27487.

1.04 QUALITY ASSURANCE

A. Items listed herein shall be products of manufacturers who have a minimum of five (5) years’ experience in the manufacture of the particular equipment item to be furnished.

1.05 GUARANTEE AND WARRANTY

A. The Manufacturer shall warrant the equipment furnished under this specification for a minimum period of one (1) year against defects in materials and workmanship, and operational failure.

B. In the event of a defect in material or workmanship or equipment design of any part or parts of the equipment during the first one (1) year of service, the Valve Manufacturer shall furnish, deliver, and replace the defective part or parts at Manufacturer’s expense.

C. The first one (1) year of service shall be defined as the 12-month period following the installation, adjusting, or 24 months after delivery, whichever occurs first.

2.00 PRODUCTS

2.01 GENERAL

A. Joint, size and material - unless otherwise noted or required by the Owner:

1. Joints referred to herein shall be of the same nominal diameter as the pipe or fittings they are connected to.
2. Appurtenance shall be of the same nominal diameter as the pipe or fittings they are connected to.

3. All mechanical couplings, flange adapters, restraint harness, etc. exposed to wastewater and/or corrosive environment shall be supplied with 304L SS hardware.

B. Insure that valves and appurtenances have ends/joints that are compatible with, and may be fastened to the adjoining pipe. This may mean furnishing special adaptors as required. These adaptors shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic non-stainless steel or galvanized, coated with two coats of Coal Tar Epoxy.

2.02 MECHANICAL TYPE WALL SEALS

A. Mechanical type seals shall consist of an adjustable modular bolted, synthetic rubber and plastic sealing element as shown on Drawings. The sealing element shall be Link-Seal LS-300-C as manufactured by Enpro Industries., or equal. Associated hardware shall be 304L SS.

2.03 SERVICE CLAMPS

A. Service clamps shall have malleable or ductile iron bodies which extend at least 360 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for IPS. Clamps shall be of the double strap design.

B. Service clamps shall be IPS service clamps as manufactured by Mueller Co., or equal.

2.04 DIELECTRIC INSULATING GASKET KITS FOR FLANGES

A. Dielectric insulating flange gasket kits shall be installed when dissimilar metal pipe connects to prevent galvanic action. Flange insulation kits shall be installed where a stainless steel flange is mated with flanges constructed of bronze alloys, carbon steel alloys, or nickel alloys (Monel, Hastelloy and Inconel) flanges; where process piping mates with valves and other equipment and appurtenances of dissimilar metals; where exposed piping makes a vertical transition to buried piping; and where otherwise as shown on the Drawings.

B. Insulating flange gaskets shall be furnished as a kit including the dielectric gasket, bolt sleeves and washers in accordance with the nominal flange size.

C. Each dielectric insulating gasket shall be a full face isolating and sealing gasket, Type “E”, 1/8” thick, epoxy-glass retainer with bolt holes cut to match matting flange drilling. The retainer shall contain a precision tapered groove to accommodate the controlled compression of a FKM (Viton) sealing element. The quad-ring seal shall be pressure energized. The epoxy-glass retainer shall have 550-volts/mil dielectric strength and a minimum 50,000 psi compressive strength.

D. Insulating bolt-sleeves shall be manufactured of Mylar having a dielectric strength of not less than 4000-volts/mil.

E. Insulating washers shall be manufactured of G-10 epoxy-glass having a dielectric strength of 400 to 500-volts/mil. Insulating washers shall be installed with metallic backing washers to prevent damage to the epoxy-glass washers during bolting. The metallic washers shall be constructed of the same material as the bolts.

F. Dielectric insulating flange gasket kits shall be:

1. Linebacker manufactured by Pipeline Seal and Insulator, Houston, Texas.
2. Trojan Quad Seal manufactured by Advance Products and Systems, Lafayette, Louisiana.
3. Jack O-ring gaskets manufactured by Central Plastics, Shawnee, Oklahoma.

2.05 HARNESSING AND RESTRAINT

A. Unless otherwise noted, size and material for tie rods, clamps, plates, and hex nuts shall be as shown on the Drawings, or in the AWWA Manual M-11. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation or fabricated equal.

B. All flexible couplings and flanged coupling adaptors shall be harnessed. Harnesses shall conform to AWWA Manual M-11 except as modified by the Drawings or this specification.

C. Restrained joints (such as welded, locking mechanical joints) shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joint pipe shall be of the manufactures standard design utilizing a locking device (ring or ears) integrally cast with the pipe.

D. For up through 18-inch diameter ductile iron pipe only the following may be used as an alternative to other restraint system:

1. The optional mechanical joint restraints shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron conforming to ASTM A 536. Dimensions of the gland shall be such that it can be used with standard mechanical joint bell and tee-head bolts as specified with the pipe.
2. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. Gripping surfaces on the pipe shall be wedges designed to spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, and shall be used to insure proper actuating of restraining devices. When the nut is sheared off, standard hex nut shall remain.
3. The mechanical joint restraint device for ductile iron pipe shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.
4. Mechanical joint restraint devices shall be of the type listed below or equal. For Ductile Iron Pipe: Flex Ring or Lock Ring by American Ductile Iron Pipe.

E. The Contractor shall be responsible for anchorage including restraint as noted in elsewhere in Division 33.

F. Restrained flange adapters shall be used in lieu of threaded or welded flanged spool pieces or at locations where dimensional constraints exist. Flanged adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10 (125#/Class 150 Bolt Pattern).

Restraint for flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.

The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

All internal surfaces of the gasket ring (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61. Exterior surfaces of the gasket ring shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.

The flange adapter shall be the Series 2100 MEGAFLANGE® Restrained Flange Adapter as produced by EBAA Iron, Inc. or equal.

2.06 SLEEVE TYPE COUPLING ("DRESSER TYPE")

A. Unless otherwise specified with the individual type of pipe, sleeve type couplings ("Dresser" type) shall be for buried pipe applications ITT (Smith Blair) Style 411, Dresser Style 38, Romac Style 400, or equal. Carbon steel or ductile iron construction with fusion bonded epoxy finish and Type 304 stainless steel hardware. If restrained couplings are indicated, use Romac Style 400RG couplings or equal.

2.07 FLANGE COUPLING ADAPTORS

A. Ductile iron or carbon steel construction with fusion bonded epoxy coating and Type 316 Stainless steel hardware, specifically designed for use with the type of pipe proposed. Furnish Dresser Style 128, Smith-Blair 911, Romac FCG, or equal by Smith-Blair. For restrained flange coupling adapters furnish Smith-Blair 911, Romac RFCA, or equal.

2.08 QUICK CONNECT COUPLINGS

A. Couplings shall be of the cam and groove type consisting of a male adapter and female receiver. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Male end with NPT pipe connection. Connections shall remain tight and leakproof under pressures up to 100 psi at 0-degress F. Each adapter shall be furnished with a dust cap complete with an 18-inch long security chain of corrosion resistant material. Polypropylene construction and Type 316 stainless steel hardware and chain. Couplings shall be Cam Lever Couplings by Banjo Corporation, Poly ProQuick by Industrial Thermoplastic Solutioins, Ever-tite by Morris Coupling Company, or equal.

B. Adapters shall be furnished in accordance with the Drawings or as required by the installation.

2.09 METAL BELLOW EXPANSION JOINTS

A. Metal expansion joints shall consist of a single hydraulically formed metal bellows with flange end fittings. Flanges shall be 304L stainless steel and ANSI 150 lb. The bellows shall be of a 304L stainless steel. Joints shall be constructed to pipe size and to meet working pressure up to 25 psi and corrosive conditions.

B. Expansion joints shall be rated for temperatures of up to 250°F and shall be capable of accommodating piping expansion up to 3”and contraction up to 1.5” and equipment movements as needed.

C. Tie rods shall be included to prevent overextension of the expansion joints from pressure thrust loads. The number and size of the control rods shall be sufficient for the maximum system test pressure.

D. Expansion joints shall be as manufactured by Hyspan, Metraflex, or equal.

2.10 MODULAR MECHANICAL EXPANDING RUBBER SEAL

A. The pipe to existing wall penetration closures shall be “Link-Seal” as manufactured by GPT EnPro or equal. Seals shall be modular mechanical type, consisting of interlocking EPDM links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with stainless steel hardware to form a continuous rubber belt around the pipe with a composite pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.

2.11 PIPE SUPPORTS

A. Adjustable pipe supports under valves and piping shall be Anvil International Figure 264 or equal, comprising cast iron saddle, threaded nipple, and reducer assembly with extra strength steel pipe and floor flange, if applicable. Provide supports with shop-primed epoxy compatible finish. For special sizes and shapes of valves, saddle shall be fabricated steel to fit valve or piping being supported.

2.12 FLOOR DRAINS

A. Floor drains shall be cast iron of the sizes indicated. Floor drains shall have a float type backwater valve with cast iron housing, plastic ball valve, renewable rubber seat, brass seat ring, and brass wire valve cage for installation in the floor drain threaded outlet. Drain design shall allow height adjustment prior to concrete slab placement. Floor drains shall be Series 30000-A and backwater valve shall be Series 67100A as manufactured by JOSAM Manufacturing Co. or equal.

2.13 WALL AND FLOOR FITTINGS

A. Wall and floor castings, unless otherwise specified with the individual type of pipe, shall be ductile iron of the style shown on the Drawings with integral exterior water stop, standard models as manufactured by American Cast Iron Pipe Company, Clow, U.S. Pipe, or equal.

B. For plastic pipe or other pipe 2-1/2 inch diameter or less wall and floor fittings shall be ASTM A120, Schedule 40 steel sleeves with exterior steel water stop, all hot dipped galvanized after fabrication.

2.14 GAUGES AND ACCESSORIES

A. Pressure gauges: All gauges unless otherwise noted be liquid filled, 316 stainless steel case and shall have 3-1/2 inch diameter face, with black letters on a white background, with pressure range as indicated on the drawings. Ashcroft Model 1009SW or equal by Robert Shaw or Ametek U.S. Gauge or Acragage.

B. Diaphragm Seal (for waste water applications): Type 316 stainless steel housing and diaphragm with threaded connections and flushing connection. Ashcroft Model 101 or equal by Ametek or Acragage.

C. Pressure Snubber: Stainless steel construction, threaded. Ashcroft Model 1112 or equal.

D. Ball valves: Type 316 body, ball and stem with removable lever handle, NPT threaded connections, rated for 250 psi minimum. SVF Flow Controls Series R8 or equal by Jamesbury or Contromatics Circor.

E. Pipe or Tubing – Schedule 40 Stainless Steel.

2.15 VALVE OPERATORS (INCLUDING FLOOR BOXES)

A. The valve manufacturer shall supply and integrally mount all operators on valves at the factory. The valves and their individual operators shall be shipped as a unit.

B. Unless otherwise noted, valves shall be manually operated; non-buried valves shall have an operating wheel, handle or lever mounted on the operator; buried valves shall have a non-rising stem with an AWWA 2-inch nut.

C. Unless otherwise required by the Owner, all manual operating input shafts shall turn to the left (counter-clockwise) to open the valve.

D. Each operating device shall have cast on it the work (OPEN) and an arrow indicating the direction of operation.

E. Floor boxes for operating nuts recessed in concrete floors shall be standard cast iron type, cast-in-place with fastening top.

F. Chain wheel operators shall be supplied for all valves: Valves larger than 3 inch in diameter whose centerline is 8 ft. or more above the floor, where required for accessibility of valve operator, or as indicated on the Drawings. Chains shall be galvanized and loop within four feet of the floor.

G. Unless otherwise noted, gear operators shall be provided for: All valves with operating shafts of larger than 8 inch nominal diameter (unless otherwise noted); for all buried valves with their operating shaft mounted horizontally (butterfly, plug, etc.); where specified and/or indicated on the Drawings; where manual operator effort is greater than 40 ft-lbs. Gear operators shall normally be of the beveled type with output shaft perpendicular to valve shaft, having a removable handwheel mounted on the output shaft. Gearing shall be machine-cut steel designed for smooth operator. Bearings shall be permanently lubricated, provided to take all thrusts and seals provided to contain lubricants. Housings shall exclude moisture and dirt. Manual operator input effort to the handwheel shall be a maximum of 40 ft-lbs. for operator the valve from full open to full close, under line pressure. Gear operators shall indicate valve position and have adjustable stops.

2.16 STRAINERS

A. "Y" Type Strainers:

1. Manual strainers furnished for pipe diameters smaller than 2 inches in diameter shall be "Y" type, capable of removing solids 0.01 inches diameter and larger. The strainer body shall be of semi-steel construction for steel pipe, and brass or bronze for copper pipe and shall conform to ASTM A278, Class 30. Strainers on plastic pipe shall be of the same material as the pipe. Strainer elements, including woven wire mesh, shall be constructed of stainless steel.
2. Design of the strainer body shall be such that the clean-out plug and screw may be easily removed to permit inspection and cleaning without disassembly of inlet and outlet piping. End connections shall be ANSI screwed pipe threads.
3. Sufficient spare screens shall be furnished for replacement of all "Y" type units at least once. Strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries, Inc., or equal.

2.17 CORPORATION STOPS

A. Corporation stops shall be of bronze or brass, and shall be designed and manufactured in accordance with AWWA Standard C800, except as modified herein. Corporation stops shall have Mueller inlet threads, except that corporation stops for use with service clamps shall have IPS threads. Where corporation stops are used with plastic pipe, a brass companion flange shall be provided on the outlet of each corporation stop.

2.18 FLEXIBLE CHEMICAL CARRIER TUBING

A. Braided clear PVC flexible tubing with a minimum working pressure 140 psi (pressure rating must be printed on tubing). For fittings, use PVC or polypropylene barbed connectors with stainless steel hose clamps.

B. Manufacturers: Finger Lake Extrusions BraidFLEX 70N, Saint-Gobian Tygon B-44-4X, Thermoplastic Processes Excelon Braided, New Age Industries Nylobrade, or equal.

2.19 INSULATION FOR PROCESS PIPING

A. Air (ALP) Piping Service

1. Insulation: Minimum 3-inch thick, ASTM C335 K-Value minimum of 0.24 at 75 degrees F. Maximum moisture absorption: 0.2 percent by volume. Service temperature range of 0 degrees F to 850 degrees F.
2. Vapor Retarder: White Kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Moisture vapor transmission - ASTM E96, 0.02 perm inches. Secure paper with self-sealing, longitudinal laps and butt strips.
3. Metal Jacket: Aluminum, ASTM B209.
4. Manufacturers: Owens Corning Fiberglas FlexWrap, Johns Manville, Knauf Fiber Glass Pipe Insulation, or equal.

B. Liquid Process Piping Service

1. Insulation shall be heavy density sectional pipe insulation slip-on tubes. Minimum insulation density shall be six pounds per cubic foot. Water absorption shall not exceed 1.0% by volume and 10.0% by weight. Water vapor permeability shall not exceed 0.20. Mildew resistance shall allow no fungal growth after 90 days incubation. Flame spread shall not exceed 35 and smoke density shall not exceed 100 per ASTM E-84. Contractor shall use manufacturer's recommended methods for jointing material. Minimum insulation thickness shall be 1½ inches. Piping insulation shall be Rubatex or equal.

2. Insulation fitting covers and jackets:

   a. Interior fitting covers shall fit snugly over fittings, including all elbows and valves, etc. Jacketing shall be high impact UV resistant covering for insulated piping and shall match fitting covers. Fitting covers and jackets shall be white and suitable for painting. PVC jacketing shall be 30 mil thick and shall be factory curled to fit snugly. Fitting covers and jacketing shall be secured with tacks. Interior insulation fitting covers shall be Zeston 2000 PVC by Manville, or equal.

   b. Exterior aluminum Jacketing shall conform to ASTM B209, and shall have a thickness of 0.032-inch sheet. The joining shall be longitudinal slip joints and have 2-inch laps. Fittings shall be 0.016-inch thick die-shaped fitting covers with factory-attached protective liner. Metal jacket bands shall be 3/8 inch wide and comprised of 0.010-inch thick stainless steel. Finish shall be embossed. Exterior insulation fitting covers shall be Childers Metals, or equal

3. Mastic Coating for Fittings: Fire-resistant, mastic coating for insulation on fittings and reinforced fiberglass cloth. Color: Metallic Gray.

4. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for the applications indicated.

2.20 APPURTENANCES AND MISCELLANEOUS ITEMS

A. Gaskets, glands, bolts, nuts, and other required hardware shall be provided for connection of piping and appurtenances. Bolts and nuts shall be high strength, Type 304 stainless steel if submerged, buried, exposed to element, in vaults or subject to splashing, or corrosive environment. All other bolts, nuts, and studs shall conform to ASTM A307 Grade B. Gaskets for flanges shall be full face and suitable for 200 degrees F operating temperature, unless higher temperature required on individual systems.

B. Plugs, caps and similar accessories shall be of the same material as the pipe, and of the locking type, unless otherwise noted.

C. Unions shall be of the same material as the pipe.

D. Special dielectric protective tape shall be fabric reinforced petroleum tape as manufactured by Denso, Inc., or equal.

2.21 PIPE COUPLINGS

A. Dresser style pipe couplings where shown on the Plans shall be Dresser Industries or approved equal, for same pressure rating as adjoining pipe. Couplings shall comprise a

steel center band, steel gland rings, gaskets, and bolts. Provide thrust harness in accordance with AWWA Manual M11 where shown on the Plans.

B. Victaulic style couplings shall be in accordance with AWWA C606. Pipe shall have shouldered or collared ends for positive thrust anchorage.

C. Split-sleeve mechanical couplings shall consist of housing, gasket assembly, bolts and nuts, and end rings as required for restraint. Couplings shall be Depend-0-Lok as manufactured by Brico Industries, Inc., or an approved equal. Coupling housing shall be manufactured from ASTM A36 Carbon Steel. Couplings installed underground shall receive a Bitumastic coating.

D. Where Victaulic couplings or restrained Dresser type couplings are shown on the Drawings for water service pipes, split-sleeve "F by F" type couplings will be allowed, provided the split-sleeve coupling is suitable for the pressures and thrust requirements, and fits in the space available for coupling. Where unrestrained Dresser couplings are shown, split-sleeve "F by E" type couplings will be allowed.

2.22 COPPER PIPE AND FITTINGS

A. Copper pipe for water service shall be Type "K" hard-drawn copper tubing. Connections shall be made using cast brass or copper sweat fittings and SiI-Fos or approved equal hard solder. Union adaptors shall be used at ends of copper lines and at connections to equipment so that piping can be disconnected without unsoldering the joints.

B. Joints in copper piping shall be soldered with ANSI/ASME B32, Grade 95TA solder. Before making up joints, copper shall be cleaned to bright metal with emery cloth and treated with nonacid type flux.

2.23 FIBERGLASS REINFORCED PIPE AND FITTINGS

A. Reinforced Fiberglass Pipe shall conform to the requirements of ASTM D2997 and ASTM D2310. Pipe shall meet or exceed the requirements for Type 2, Grade 1, Class "C" pipe and have a 60-mil resin-rich liner. Minimum wall thickness shall not be less than 0.2 inch.

B. Fittings shall conform to or exceed the requirements of the pipe and shall be produced from epoxy resin.

C. Connections shall be flanged. Gasket material shall be of an elastomer which shall provide chemical resistance for the service required. Gasket material shall be 3/16-inch thick, full-faced design, with a Durometer Shore "A" reading of 40-60 and shall be BUNA-N, Neoprene, Viton, Hypalon, or approved equal.

D. The reinforced fiberglass pipe, fittings, and gaskets shall be capable of handling water temperatures up to 250 degrees and water pressures up to 300 psi.

2.24 EMERGENCY EYEWASH/SHOWER

Furnish and install combination eyewash/shower emergency unit, connecting piping and drain. Unit shall comply with OSHA regulations and ANSI standards. Each unit shall be freeze-proof and capable of operating at temperatures as low as 10 F. 10-inch deluge shower head and twin-face-wash spray unit shall be individually operated and instant-

action. Water supply shall be buried. Unit shall be Haws Model 8300FP, or approved equal.

3.00 EXECUTION

3.01 INSTALLATION GENERAL

A. Items shall be installed per Manufacturer's instructions in the locations shown. Damage to items shall be repaired to the satisfaction of the Owner before they are installed.

B. Install brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting items, check Drawings which have a direct bearing on their location to be responsible for the proper location of these appurtenances during construction of structures.

C. Items shall be carefully inspected for defects in construction and materials; debris and foreign material cleaned out of openings, etc.; operating mechanisms operated to check their proper functioning, and nuts and bolts checked for tightness. Equipment which does not operate easily, or is otherwise defective, shall be repaired or replaced.

D. Where installation is covered by a referenced Standard Specification, installation shall be in accordance with that Specification, except as herein modified.

E. Unless otherwise noted, joints for items shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint.

3.02 INSTALLATION OF SLEEVE (DRESSER) TYPE COUPLINGS

A. Unless otherwise required by the manufacturer's instructions, prior to installation of sleeve-type couplings, pipe ends shall be cleaned thoroughly for a distance of at least 12 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end, the middle ring shall be placed on the already installed pipe and shall be inserted into the middle ring flair and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.

B. After the bolts have been inserted and nuts have been made up finger tight, diametrically opposite nuts shall be progressively and uniformly tightened around the joint, by use of a torque wrench of the appropriate size and torque for the bolts.

C. The correct torque as indicated by a torque wrench shall not exceed 75 ft-lb for 5/8-inch bolts and 90 ft-lb for 3/4 inch bolts.

D. If a wrench other than a torque wrench is used, it should be no longer than 12 inches so that when used by the average person the above torque values shall not be exceeded.

E. To prevent sleeve-type couplings from pulling apart under pressure, a suitable harnessing or flange clamp assembly shall be provided and installed where shown on the Drawings, or required elsewhere under Division 15 concerning Anchorage.

F. Note the additional locations required for sleeve couplings per Part 2 of this Section.

3.03 FLANGED COUPLINGS ADAPTERS

A. Flanged coupling adapters shall be installed in strict accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the proper locations of holes for the anchor studs shall be determined and the pipe shall be field-filled. Holes for anchor studs shall be drilled completely through the wall pipe. Hole diameter shall not be more than 1/8 inch larger than the diameter of the stud projection.

B. The inner surface of couplings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except flange mating surfaces, shall be cleaned and shop primed with universal primer.

3.04 INSTALLATION OF EXPANSION/VIBRATION ISOLATION FITTINGS

A. Piping systems shall be aligned prior to installation of expansion fittings. Alignment shall be provided by fitting a rigid pipe spool in place of the expansion joint. Prior to testing of the piping system, the pipe spool shall be replaced with the specified expansion fitting.

B. In addition to the locations noted on the Drawings, and in Part 2 of this Section, expansion fittings and anchors shall be located and spaced as specified by the Expansion Joint Manufacturer's Association under ambient conditions. They shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

C. Manufacturer shall provide field representative during installation of expansion joints.

D. Manufacturer's field representative shall certify installation of expansion joints.

3.05 INSTALLATION OF WALL AND FLOOR FITTINGS

A. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as shown. Support all pipes embedded in concrete walls, floors, and slabs with form work to prevent contact with the reinforcing steel.

3.06 INSTALLATION OF OTHER EQUIPMENT, APPURTENANCES AND MISCELLANEOUS ITEMS

A. Unions and wall fitting shall be installed as indicated on the Drawings.

B. Hardware and appurtenances shall be installed as required and in accordance with the Manufacturer's recommendations, as acceptable to the Owner.

C. Use teflon tape on screwed fittings.

3.07 FIELD PAINTING

A. Field painting is specified in Division 09. Buried metal items or those in vaults shall receive two coats of coal tar epoxy. The total DFT shall be 16 to 20 mils.

END OF SECTION

33 01 03 SUPPORTS AND HANGERS

1.00 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, tools and related items required to furnish and install all pipe hangers, brackets, saddles, clamps and pipe rolls for all types of piping and duct systems. Pipe hangers and supports shall be furnished complete with all necessary inserts, bolts, nuts, threaded rods, washers and other accessories.

1.02 SUBMITTALS

A. Submittals shall comply with Section 01 33 00 “Submittal Procedures”. Submittals, Shop Drawings and, Product Data shall include the maximum load carrying capacity of the support and the support system arrangement.

B. Submit product data and details on each support.

1. Product data on each support component.
2. Detail of each different type of support on pipe 3 inches and larger.
3. Location of each pipe support on pipe 3 inches and larger.

1.03 REFERENCE STANDARDS

A. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-58 - Pipe Hangers and Supports, Materials Design and Manufacture.
2. SP-69 - Pipe Hangers and Supports, Selection and Application.

B. The above documents form a part of this specification to the extent specified herein.

1.04 QUALITY ASSURANCE

A. Pipe supports shall be manufactured by a company regularly engaged in the production of pipe supports such as B-Line, Piping Technology Products, or Anvil International.

1.05 DESIGN CONDITIONS

A. In certain locations, pipe supports, anchors, and expansion joints have been shown on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be the Contractor's responsibility to design, furnish and install a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with this section. Additional pipe supports may be required adjacent to expansion joints or couplings.

B. Concrete and fabricated steel supports shall be as indicated on the drawings, as specified in other sections or, in the absence of such requirements, as permitted by the Engineer.

C. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports with pipes full of fluid.

2.00 PRODUCTS

2.01 MATERIALS

A. Design and Construction. Pipe hangers and supports shall be designed and constructed to meet the requirements of MSS SP-58 and SP-69.

B. All hangers, brackets, clamps, and supports shall be Type 304 stainless steel unless noted otherwise. Do not use perforated strap hangers. When two (2) or more pipes are run parallel, they may be supported on trapeze hangers.

C. All piping in chemical and corrosive areas shall be supported with support assemblies, including framing hardware and anchors, constructed of Type 304 stainless steel or FRP, unless otherwise indicated.

D. Unless otherwise shown on the drawings, all horizontal runs of piping suspended from the walkways or roof construction, as the case may be, shall be suspended by means of approved hangers.

E. All individually suspended horizontal pipes in the building shall be supported by Type 304 stainless steel rods sized as follows:

Pipe Size (in Inches)	Rod Size (in Inches)
2 and smaller	3/8
2-1/2 - 3-1/2	1/2
4 - 5	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 24	1-1/4

F. Channel struts and pipe clamps may be used to support multiple lines running in close proximity. Use expansion shields with bolts and horizontal drilled holes in existing concrete construction to support new piping.

G. Metal Framing:

1. Provide channels fabricated from not less than 12-gauge sheet steel, 1-5/8” wide and not less than 1-5/8” deep.

2. Use Type 304 stainless steel channels and components.

3. All anchor bolts shall be 316L stainless steel. Space anchor bolts a maximum of 24” on center, with not less than two bolts per piece of framing.

4. Acceptable Manufacturers:

B-Line Systems, Inc., Power Strut, or Unistrut.

H. Continuous slotted inserts may be used to support multiple lines running in close proximity on either individual hangers or on trapeze. Use expansion shields with bolts and horizontal drilled holes in existing concrete construction to support new piping.

I. Hangers supporting and contacting copper lines three inches in size and smaller shall be hinged ring hangers and adjusters. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion by: wrapping pipe with 1/16-inch thick neoprene sheet material and galvanized protection shield; isolators similar to Elcen Figure 228; or copper plated or PVC coated hangers and supports.

J. Hangers supporting four inches and larger ferrous pipe shall be with two nuts for each support.

K. All vertical risers shall be supported by riser clamps or supports at each floor and every five feet. Install four-inch square plate on masonry with attached rod using hangers fastened to risers.

L. Where supports or anchors are used on copper piping, copper plate U-bolts and chairs or rubber inserts to eliminate dissimilar metal contact.

M. For horizontal piping along equipment room walls, use brackets with hangers and rods as specified unless otherwise shown on the Drawings.

N. Install supports and hangers to permit free expansion and contraction in the piping system. Where necessary to control expansion and contraction, piping shall be guided and firmly anchored. Anchors shall be acceptable to the Engineer. Design for equal effectiveness for both longitudinal and transverse thrust. No piping shall be self-supporting, nor shall it be supported from equipment connections. Transmission of vibration, noise, etc., shall be considered, and any special suspension with vibration dampeners to minimize transmission shall be used where necessary. Shooting of anchors into concrete will not be allowed.

O. Where ducts interfere with the proper location of hangers, furnish and install trapeze hangers.

2.02 TYPE

A. Pipe hangers and supports shall be selected from one of the types shown on Figure 1 of MSS-58 and MSS-69 or as indicted on the drawing, where applicable. Plastic pipe support spacing shall be in accordance with plastic pipe manufacturer recommendations.

B. Brackets shall be 304 stainless steel in an accordance with MSS SP-69, Type 32 rated for 1,500 pounds

C. Adjustable Pipe Saddle Support with U-Bolt shall be 304 stainless steel in accordance with MSS SP-69, Type 37.

D. Roller Chair Supports shall be 304 stainless steel in accordance with MSS SP-69, Type 44.

E. Roller Supports shall be 304 stainless steel in accordance with MSS SP-69.

F. Pipe Rollers shall be 304 stainless steel in accordance with MSS SP-69.

3.00 EXECUTION

3.01 INSTALLATION

A. Pipe Support Spacing:

1. General:

a. Locate pipe supports at maximum spacing scheduled unless indicated otherwise.

b. Provide at least one support for each length of pipe, at each change of direction, and at each valve.

c. Locate pipe supports as shown in Table 3 of MSS-69 for piping not scheduled below or shown otherwise.

d. Provide continuous support as required for small tubing to properly support the tubing along the pipe run and at connections to equipment.

2. Steel, Stainless Steel, Cast-Iron Pipe Support Schedule (for pipes carrying water):

PIPE SIZES - IN	* MAXIMUM SPAN (FT)	ROD SIZE - IN
2 and less	5	3/8
2½ thru 3½	10	1/2
4 thru 5	10	5/8
6	10	3/4
8 thru 12	15	7/8

3. Copper Pipe Support Schedule:

PIPE SIZES - IN	* MAXIMUM SPAN (FT)	ROD SIZE - IN
2-1/2 and less	5	1/2
3 thru 6	10	3/4
8 and greater	15	7/8

4. PVC, ABS Pipe Support Schedule:

PIPE SIZES - IN	* MAXIMUM SPAN (FT)	ROD SIZE - IN
1-1/4 and less	3	3/8
1-1/2 thru 3	4	1/2
4 and greater	5	3/4

*Maximum fluid temperature of 120 Deg F.
Support spacings apply to continuous spans with no concentrated load.

B. Application:

1. Support piping approximately 1-1/2 inches out from the face of walls and at least three inches below ceilings.

2. Concrete inserts or L-shaped anchor bolts shall be used to support piping from new cast-in-place concrete. Epoxy or Expansion anchors shall be used to fasten supports to existing concrete and masonry.

3. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

4. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Threaded rods shall be sufficient threading to permit the maximum adjustment available in the support item.

5. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

6. Pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required when mechanical couplings are permitted as expansion joints. Guides shall be placed on both sides of expansion joints except where anchors are adjacent to the joints. Unless otherwise indicated on the drawings, one guide shall be within four pipe diameters from the joint and a second guide with 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for support. Pipe guides shall be installed as recommended by the manufacturer.

7. Concentrated loads (valves, flanges, etc.) shall be supported directly or supported immediately adjacent to the load.

8. Changes in the direction shall be supported as close as practical to the fitting to avoid introducing excessive torsional stresses into the system.

9. Valves shall be braced against operating torque.

C. Adjustment: All hangers shall be adjustable. Wall hangers shall have slotted bolt holes. Ceiling hangers shall have turnbuckles. Floor supports shall have extended anchor bolts such that the support can be wedged to proper elevation and grouted. Provide a minimum of one inch of grout.

D. Pipe Rack: Pipe supported on pipe rack shall be supported on channels manufactured by Unistrut, Powerstrut or equal. Clamp pipes on the channel support by pipe clamps of the same manufacturer.

E. Touch Up:

1. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent zinc paint.

2. Use a PVC compound on PVC-coated components.

3.02 INSULATED PIPE

A. Insulated pipe shall have protective saddles where supported. Insulation shall pass through the supports. Size supports for the full outside diameter of the insulation.

3.03 PLASTIC OR FIBERGLASS PIPE

A. Plastic or fiberglass pipe shall have cradles and rubber pads to distribute the load over a length of at least six inches, or more if indicated on the drawings, at all supports.

END OF SECTION

33 05 01.02 DUCTILE IRON PIPE & FITTINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install ductile iron pipe and fittings, including taps, connections, and appurtenances as required for a functional system as indicated herein. Unless otherwise noted, all above grade exposed pipe, fittings, and appurtenances shall be flanged while below grade piping, fittings and appurtenances shall be mechanical joint or push on joints. Trenching, backfilling, and pipe embedment shall be as shown on the Drawings and in accordance with Section 31 23 33.19 "Trenching and Backfill."

1.02 QUALITY ASSURANCE

A. Factory Testing: The manufacturer shall perform all tests as required by AWWA C151. Welded outlets shall be hydrostatically tested at a pressure of 250 psi for a period of 1 hour. No leakage shall be allowed.

B. Experience Requirements: Pipe shall be the product of a manufacturer who has a minimum of 10 years' successful experience manufacturing pipe of the particular type specified and the total pipeline shall be the product of one pipe manufacturer. The manufacturer shall have a minimum of 10 years' successful experience in the design and manufacturing of pipe joints of similar design, working pressure, pipe diameter and wall thickness as specified.

C. Pipe Classification: Pipe manufacturer shall manufacture the pipe to meet the installation conditions, cover depth, and bedding and backfill requirements as shown on the Drawings or specified and furnish the correct class of pipe to meet these conditions. If additional requirements are required, pipe manufacturer shall coordinate their requirements with the Contractor.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Record Data: Catalog data, including dimensions of new pipe and fittings and recommendations for handling and storage; details of lining and coating; thrust restraint provisions; hydrostatic pressure test plan and results; affidavit stating the pipe furnished complies with AWWA C151, AWWA C104, AWWA C110, AWWA C111, and these specifications; mill certificates, including chemical and physical test results for each heat of metal, if requested during pipe manufacturing operations; record drawings, including a schematic location-profile and a tabulated layout schedule, referenced to the pipeline stationing.

2. Shop Drawings: Mechanical joint connections; connections to differing pipe materials.

3. Certified Test Data: Certified Test Reports from the manufacturer's testing facility or an Owner approved testing laboratory; results of factory hydrostatic tests.

1.04 REFERENCE SPECIFICATIONS

A. Section 31 23 33.19 “Trenching and Backfill.”

1.05 STANDARDS

A. Except as modified herein, the applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Water Works Association (AWWA) Standards:

AWWA C104	Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C105	Standard for Polyethylene Encasement for Ductile Iron Piping
AWWA C110	Standard for Ductile Iron and Gray Iron Fittings
AWWA C111	Standard for Rubber Gasket Joints for Ductile Iron Pipe and Fittings
AWWA C150	Standard for Thickness Design of Ductile Iron Pipe
AWWA C151	Standard for Ductile Iron Pipe
AWWA C153	Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C600	Standard for Installation of Ductile Iron Water Mains and Appurtenances
AWWA C606	Grooved and Shouldered Joints

2. Steel Structures Painting Council (SSPC) Standard: SSPC SP6, Commercial Blast Cleaning.

3. All ductile iron pipe and fittings for potable water systems shall conform to American National Standards/National Science Foundation (ANSI/NSF) Standard 61 and must be certified by an organization accredited by ANSI.

1.06 DELIVERY AND STORAGE

A. Handling and storage of pipe and fittings shall comply with AWWA C600 and the manufacturer’s recommendations.

1.07 GUARANTEES

A. The product shall be warranted and guaranteed per the General Conditions of the Specifications.

2.00 PRODUCTS

2.01 MATERIALS

A. Ductile Iron Pipe:

1. Ductile iron pipe shall be made of ductile iron in accordance with AWWA C151. All ductile iron pipe shall have a minimum working pressure as indicated on the Drawings. Pipe shall be rated for pressure in accordance with AWWA C151 for pressure class of pipe as indicated. Standard joint length shall be 18 to 20 feet. Flanged ductile iron pipe shall be in accordance with AWWA C115.

2. Pipe manufacturer shall manufacture the pipe to meet the installation conditions, cover depth, and bedding and backfill requirements as shown on the Drawings or specified and furnish the correct class of pipe to meet these conditions.

B. Fittings: Fittings shall be ASTM A536 ductile iron or ASTM A48 cast iron in accordance with AWWA C110. Fittings shall be rated for a minimum working pressure of 250 psi, unless specified otherwise. Factory welded outlets may be used in lieu of tee fittings for 18-inch and larger tee fittings. Factory welded outlets shall have a minimum pressure rating of 250 psi. Factory welded outlets may not be used near sources of vibration, such as pump stations or roads.

C. Joints for Pipe and Fittings:

1. Joints shall be in accordance with AWWA C110, AWWA C111, and AWWA C151. Standard joints for ductile iron pipe and fittings shall be push-on. Where indicated, joints shall be mechanical joint, flanged, or grooved.

2. Flanged joints shall have pressure ratings equal to or greater than adjacent pipe. Flange pattern shall match pattern of valve, fitting, or appurtenance to be attached. Flanges on ductile iron pipe shall be ductile iron.

3. Grooved joints may be used in lieu of flanged. Where used in lieu of flanges, grooved joints shall be of the rigid type, in accordance with AWWA C606.

4. Where indicated, grooved joints in accordance with AWWA C606 shall be used. Grooved joints shall be flexible unless indicated otherwise. All grooved joint couplings and fittings shall be of a single domestic manufacturer.

D. Provisions for Thrust:

1. Thrust at bends, tees, plugs, or other fittings shall be resisted by restrained joints. If thrust cannot be accommodated using restrained joints, thrust blocking or concrete anchors to restrain thrust may be used on a case-by-case basis when approved by the Engineer.

2. Restrained joints shall be used for a sufficient distance from each bend, tee, plug, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purpose of thrust restraint, design pressure shall be 1.5 times the design working pressure class indicated.

3. The length of pipe with restrained joints to resist thrust forces shall be determined by the pipe manufacturer in accordance with Thrust Restraint Design for Ductile Iron Pipe, Ductile Iron Pipe Research Association using the following parameters:

a. Laying condition equal AWWA C600 Type 4 bedding.

b. If polyethylene encasement is used, restrained length shall be doubled to account for reduced soil to pipe friction resistance.

4. Where indicated and where required for thrust restraint, joints shall be restrained. Restrained joints shall be mechanically interlocking joints. Restrained joints shall be U.S. Pipe "TR Flex", American Ductile Iron Pipe "Flex Ring", or Clow Corporation "Super-Lock". Restraining fittings using set screws, restraining gaskets, gripper type glands, and field-cuts of restrained joints shall be Mega-Lug, or approved equal. Field welding shall

not be allowed. Restrained joints shall be capable of sustaining the design pressure as specified herein.

E. Coating:

1. Coat the exterior of the pipe and fittings with a 1 mil bituminous coating in accordance with AWWA C110 and AWWA C151, unless specified otherwise.

2. In addition to the factory applied asphaltic coating, all buried ductile iron pipe and fittings shall have a tube-type polyethylene encasement in accordance with AWWA C105. Polyethylene encasement shall be 8 mils thick. Both ends of the pipe shall be thoroughly sealed with adhesive tape or plastic tie straps at the joint overlap. Place circumferential wraps of tape at 2-foot intervals along the barrel of the pipe to minimize the space between the encasement and the pipe.

F. Lining: Ductile iron pipe and fittings shall have a cement mortar lining in accordance with AWWA C104 and bituminous seal coat. Thickness of lining shall be as specified in AWWA C104. Air piping shall not be lined.

G. Flexible Joint Couplings:

1. Flexible joint couplings shall be Dresser Style 38, Rockwell Style 411, Victaulic Depend-O-Lok - E x E, Type II or approved equal for unrestrained joints, unless otherwise shown.

2. Provide restrained flexible joint couplings or restrained flexible joints on all pipes connecting to concrete structures and at other locations shown on the Drawings. Restrained flexible couplings shall be Victaulic Depend-O-Lok F x F Type II , restrained Dresser**,** or approved equal. Restrained flexible joints shall be U.S. Pipe "TR Flex", American Ductile Iron Pipe "Flex Ring", Clow Corporation "Super-Lock", or approved equal.

H. Insulated Connections: Where insulated connections are indicated, the pipe manufacturer shall furnish dielectric insulation gaskets, sleeves, and two plastic washers for each bolt. Insulating kits shall be Insulket or approved equal.

3.00 EXECUTION

3.01 INSTALLATION

A. General: Install ductile iron pipe, fittings, specials, valves, and hydrants in accordance with AWWA C600 and the Specifications. Trenching and backfilling shall be in accordance with Section 31 23 33.19 “Trenching and Backfill.” Before lowering into the trench, inspect each joint of pipe. Pipe will then be accepted, rejected, or repaired.

B. Pipe Laying: Lower pipe, fittings, and special castings into trench by crane or other suitable method. Do not roll in or "dump" into the trench. Handle pipe and fittings with belts, slings, or other equipment designed to prevent damage to the pipe and coating. Remove dirt and trash that may be in the barrel of the pipe, on the spigot or in the bell while the pipe is suspended. Keep the pipe clean during the laying operation and free of sticks, dirt, and trash, and at the close of each operating day seal the open end of the pipe with a gasketed night cap. Do not lay pipe in water.

C. Pipe Alignment: Install pipe and fittings to the line and grade indicated. In areas where the line and grade indicated cannot be achieved using standard manufactured bends and

fittings, make slight adjustments by deflecting joints. Joint deflections may not exceed the lesser of the maximum deflections stipulated in AWWA C600 or 75 percent of the manufacturer's maximum recommended deflection. Resolve any conflicts with existing utilities and structures.

D. Joint Making:

1. Jointing Mechanical Joint Pipe:

a. Joint this type of pipe in accordance with the manufacturer's recommendations, with uniform torque on bolts.

b. After carefully cleaning both spigot and bell and after slipping the follower ring and gasket over the spigot end, slip the spigot into the bell. Apply a lubricant to the spigot to assist in assembly.

c. Carefully seat the gaskets by hand to be even in the bell at all points.

d. After drawing up the follower ring to uniform bearing against the gasket, insert the bolts and tighten by hand in pairs using bolts opposite each other.

e. Tighten the nuts to hold the required pressure. Extension wrenches or pipes over wrench handles shall not be permitted. Use 10-inch ratchet wrenches to tighten the nuts to a uniform torque.

f. The finished joint shall be watertight.

2. Making Flanged Joints: Erect flanged pipe in accordance with the controlling dimension as specified. Thoroughly clean each piece of flanged pipe to remove dirt, rust, grease, and other foreign matter. Thoroughly wire brush flanged faces to ensure even bearing for gaskets and mating flanges. Place full face gasket, use drift pins to align holes, and tighten flange bolts, each in turn, at a uniform torque around the joint. Finished joints shall be watertight.

3. Making Push-On Joints:

a. The jointing of this type of joint shall be as recommended by the manufacturer. The procedure for jointing shall be generally as follows:

1). Thoroughly clean and dry the spigot and bell before starting the assembly of the joint. Wipe the gasket clean with a cloth.

2). Place the gasket into the gasket seat in the bell.

3). Apply a thin film of lubricant to the surface of the gasket that will come in contact with the entering pipe spigot. If necessary, also apply lubricant to the spigot.

4). Make the joint by exerting sufficient force on the entering pipe so that its plain end will move past the gasket to the seat of the bell.

5). If restrained joints are used, orient pipe to permit ease of assembly. Place locking device after installation of spigot into bell.

4. Making Split-Sleeve Coupling Joints:

a. Exterior surfaces of the pipe shall be clean, smooth and free from weld beads, seams, scars, indentations, roll marks, exterior coatings and flat spots.

b. Install split-sleeve couplings in accordance with the manufacturer's latest installation instructions.

E. Polyethylene Encasement: Wrap bituminous coated ductile iron pipe in polyethylene encasement in accordance with AWWA C105. Repair or replace encasements which have tears, rips, or punctures in the polyethylene wrap.

F. Painting: Paint piping which is submerged or exposed to the atmosphere in accordance with Section 09 96 00.01 "High-Performance Coatings."

3.02 FIELD QUALITY CONTROL

A. Perform a hydrostatic test as specified in Section 01 40 00 "Quality Management."

END OF SECTION

33 05 01.07 REINFORCED CONCRETE PIPE

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to furnish and install reinforced concrete pipe and fittings, joints, and connections to new or existing pipe or headwalls, manholes, etc., to the lines and grades and at the diameters indicated on the Drawings. For pipe to be installed by microtunneling/pipe jacking methods, such pipe shall be furnished and installed in accordance with the requirements of Section 33 30 00 "Microtunneling." For pipe to be installed by open cut methods, trenching, backfilling, and embedment for such pipe shall be performed in accordance with the requirements of Section 31 23 33.19 "Trenching and Backfill [Plant Construction]."

B. The Work to be performed in this Section includes design calculations, detailing, and fabrication of pipe. Pipe design and associated calculations shall be performed by a Professional Engineer licensed in the State of Texas who is employed or retained by the Contractor. The design of the pipe shall include the selection of external loads, installation loads, and other loads as determined by the Contractor.

1.02 QUALITY ASSURANCE

A. Experience:

1. Pipe must be the product of one manufacturer with not less than five (5) years of successful experience manufacturing pipe of the type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, and coating) must be performed at one location unless otherwise acceptable to the Engineer.

2. Furnish an affidavit that the pipe, specials, fittings, and appurtenances furnished comply with all provisions of this Section and applicable ASCE and ASTM standards.

B. Owner Testing and Inspection: Pipe may be subject to inspection during manufacture by an independent testing laboratory selected and retained by the Owner or the Engineer. Representatives of the independent testing laboratory and the Engineer shall have access to the Work whenever it is in preparation or progress, and the pipe manufacturer must provide proper facilities for access and for inspection. The pipe manufacturer must notify the Owner in writing a minimum of two (2) weeks prior to pipe fabrication so that the Owner may advise the manufacturer as to the Owner's decision regarding tests to be performed by the independent testing laboratory. Material, fabricated parts, and pipe found to be defective or not conforming to the requirements of this Section will be subject to rejection at any time prior to Owner's final acceptance of the Project.

C. Factory Testing: At a minimum, the following tests must be conducted at the factory, with test results furnished to the Owner and Engineer:

1. The acceptability of the pipe shall be determined by the results of the three edge bearing test for the load to produce the 0.01-inch crack and the ultimate load; by such material tests as are required in ASTM C76; by absorption tests on selected samples from the wall of the pipe; and by inspection of the finished pipe to determine its conformance with the design prescribed in these specifications and its freedom from

defects. Three edge-bearing tests for the 0.01-inch crack only shall be performed on 0.8 percent of the pipe joints or two pipe joints, whichever is larger. Three edge bearing tests for both the 0.01-inch crack and the ultimate load shall be performed on 0.2 percent of the pipe joints or two pipe joints, whichever is larger.

2. As an alternate to the three edge bearing test, concrete pipe 60 inches in diameter and over may be accepted, at the option of the Owner, on the basis of material tests and inspection of the completed product. Acceptability of pipe on this basis shall be determined by the results of material tests as required in ASTM C76; by crushing tests on cores taken from the barrel of the completed and cured pipe; by absorption tests on samples from the wall of the pipe; and by inspection of the finished pipe including amount and placement of reinforcement, to determine its conformance with the design prescribed in these specifications and its freedom from defects. The manufacturer shall furnish facilities and personnel for taking the cores from the pipe barrel and for determining the compressive strength of the samples. When the cores cut from a section of pipe successfully meet the strength requirement, the core holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section shall meet the tests requirements of ASTM C76. Pipe sections, so sealed, shall be accepted for use.

D. Workmanship and Finish:

1. Pipe shall be free from fractures, large or deep cracks, defects that indicate imperfect manufacturing, surface defects indicating honeycombed or open texture, damaged ends that would prevent making satisfactory joints, any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more. The ends of pipe shall be perpendicular to the walls and centerline of the pipe within the limits of variations.

2. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. Rejected pipe shall be plainly marked by the Engineer and shall be replaced by the Contractor with pipe which meets the requirements of these specifications. Remove rejected pipe immediately from the Site.

3. In event of accidental damage during handling or upon observation of minor imperfections, Contractor shall make the necessary repairs and replacements as recommended by the pipe manufacturer at no additional cost to the Owner. The Engineer may accept pipe with repairs that are sound, properly finished, and cured in conformance with pertinent specifications.

E. Manufacturer's Technician for Pipe Installation: Pipe manufacturer must furnish the services of a factory trained, qualified, field experienced technician during installation. The technician must assist and advise the Contractor in his pipe installation operations and must instruct construction personnel in proper joint assembly and joint inspection procedures. The technician is not required to be on-site full time. However, the technician must be on-site during the first two (2) 8-hour days of pipe installation and thereafter three (3) additional 8-hour days as requested by the Engineer, Owner, or Contractor.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Submittals for “Jacking Pipe” as required by Section 33 30 00 “Microtunneling.”

2. Manufacturer’s product data sheets, drawings, specifications and other data, showing complete details of the fabrication and construction of each size and type of pipe and fittings, together with complete data covering all materials proposed for use, including the following:

a. Pipe classification.

b. Name of manufacturer.

c. Nominal pipe diameter.

d. Concrete mix design.

e. Laying lengths.

f. Joint and gasket details.

g. Jointing methods and tolerances.

h. Minimum radii for horizontal deflection.

i. Details of reinforcement.

j. Details of lubrication and grouting ports.

k. Details of fittings and specials.

3. Pre-Construction submittal data and specifications shall include, but shall not be limited to, the following for each size and type of pipe:

a. Manufacturer and manufacturer’s qualifications.

b. Manufacturing Details. Description and specification of the manufacturer and methods of manufacture including forms, reinforcing, casting, covering, and storage.

c. Material Properties. Submit data in support of the materials used meet or exceed the specified properties for all materials used including, reinforcing, gaskets, and protective lining, if applicable.

d. Shop drawings showing pipe details including:

1). Pipe size, wall thickness, length, and dimensions.

2). Reinforcing size, grade, spacing in both directions, and cover.

3). Joint details with type and configuration sizes, dimensions, and gasket grooves.

4). Grout port arrangement and details.

5). Fabrication tolerances for all pipe dimensions.

6). Shop drawings shall be prepared, signed, and sealed by a Professional Engineer licensed in the State of Texas employed or retained by the Contractor.

e. Detailed structural calculations for the pipe confirming the pipe can adequately resist anticipated installation loads, including handling and jacking loads, in-situ and service loads, and all other associated design loads, provides the required factor of safety against buckling, and meets the required maximum allowable long-term deflection.

1). Calculations shall show loading and other design criteria, design standards, formulas, assumptions, loads, methods of analysis intermediate steps, and results of stresses and displacements.

2). If computer calculations are performed, example calculations shall be furnished to show the procedures used by the software.

3). Calculations shall be submitted showing that pipe and joints can adequately resist anticipated installation loads, including handling and jacking loads, in-situ and service loads, and all other associated design loads with required factors of safety.

4). Calculations shall be prepared, signed, and sealed by a Professional Engineer licensed in the State of Texas employed or retained by the Contractor.

f. Pipeline layout and profile drawings showing the location, stationing, and invert elevations of pipe sections, fittings, and closure pieces, if applicable.

g. Handling and storage details and shop drawings of methods of transportation from the manufacturing location to the site and methods and equipment used to handle and store.

4. Prior to shipment of the pipe, the pipe manufacturer shall submit the following:

a. A Certificate of Adequacy of Design stating the pipe to be furnished complies with ASCE/CI 27-17, ASTM C76, and these specifications.

b. Certified Test Reports from the manufacturer's testing facility or an acceptable testing laboratory for the factory testing required herein. Test reports shall include certification of compliance with specified standards.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 "Document Management."

B. Section 01 40 00 "Quality Management."

C. Section 31 23 33.19 "Trenching and Backfill [Plant Construction]."

D. Section 33 23 24 "Contact Grouting."

E. Section 33 30 00 "Microtunneling."

1.05 STANDARDS

A. The applicable provisions of the following standards must apply as if written here in their entirety. Piping and fittings must be in full compliance with the applicable standards and specifications. Pipe may be rejected for failure to comply with any requirement of this Section. Whenever a conflict exists between the standards and the requirements herein or between separate standards, the most stringent requirement shall govern.

1. American Society of Civil Engineers (ASCE) Standards:

ASCE/CI 27-17	Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
ASCE/CI 36-15	Standard Design and Construction Guidelines for Microtunneling

2. ASTM International (ASTM) Standards:

ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C150	Standard Specification for Portland Cement
ASTM C361	Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C497	Standard Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C822	Standard Terminology Relating to Concrete Pipe and Related Products
ASTM C985	Standard Specification for Nonreinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe
ASTM C1417	Standard Specification for Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design
ASTM D2240	Standard Test Method for Rubber Property – Durometer Hardness

1.06 DESIGN CRITERIA

A. Pipe, joints, and gaskets shall be designed and furnished by the Contractor in accordance with the requirements of the standards listed herein except as modified or supplemented herein.

B. Pipe Inside Diameter: Refer to the Drawings.

C. Installation Tolerances: Refer to Section 33 30 00 – Microtunneling.

D. Design Earth Cover Height Above the Top of the Pipe: Refer to the Drawings.

E. In Situ Soil Characteristics and Water Table Elevation: Refer to the Geotechnical Baseline Report and Geotechnical Data Report.

F. Live Load: Equal to HS-20.

G. Surcharge Load: As determined by the Contractor during construction.

H. Groundwater Load: Refer to the Geotechnical Baseline Report and Geotechnical Data Report.

I. Intermittent Hydrostatic Pressure or Other Loads: Assume Maximum Water Surface Elevation of 21.00 feet with the pipe empty or pipe full of water.

J. Minimum Concrete Compressive Strength: 5,000 PSI.

K. Refer to additional design criteria provided in Section 33 30 00 – Microtunneling.

1.07 DELIVERY, HANDLING, STORAGE, AND MARKING

A. An inspection of the pipe will be made by the Engineer after delivery. Contractor shall make periodic inspections of stored pipe materials to assure that materials are maintained under specified conditions and free from damage or deterioration. Pipe with visible defects will be rejected and replaced at no additional cost to the Owner. Visible defects include cracks of any type, honeycombs, delamination, or any other defects indicative of poor workmanship. Any pipe rejected shall not be returned under any circumstances to the Project.

B. Pipe damaged in shipment shall not be unloaded at the Site.

C. Deliver, handle, and store pipe in accordance with the manufacturer's recommendations.

D. Pipe Marking: The following information shall be clearly marked on each section of pipe by the pipe manufacturer:

1. The class or D-load of pipe,
2. ASCE and/or ASTM standard designation,
3. The date of manufacture and identification of plant,
4. The name or trademark of the manufacturer,
5. Diameter of the pipe,
6. Identification number corresponding to the laying schedule, and
7. Top centerlines must be marked on all specials.

2.00 PRODUCTS

2.01 MATERIALS

A. General: Except as modified herein, materials, manufacture, and design of pipe, fittings, joints, reinforcing, and appurtenances shall conform to ASCE/CI 27-17 and ASTM C76.

1. Cement: ASTM C150, Type II.
2. Fine Aggregate: ASTM C33.
3. Gaskets: ASTM C361, Section 6.9, standard gasket. Hardness shall be 40 for concrete joints and 60 for steel joints when measured by ASTM D2240, Type A durometer. Polymer shall be synthetic rubber. Natural rubber shall not be acceptable. Gaskets shall be furnished by the pipe manufacturer.

2.02 MIXES

A. Mix concrete in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete shall not be acceptable for use.

2.03 MANUFACTURED PRODUCTS

A. Pipe and Fittings:

1. Except as modified herein, pipe shall be in accordance with ASTM C76 for Class V Reinforced Concrete Pipe, Wall C. Fittings shall be suitable for and compatible with the class and type of pipe for which they will be used.

2. Pipe to be installed by microtunneling/pipe jacking methods shall be suitable for the type and size of the microtunneling/pipe jacking equipment selected by the Contractor and shall be in accordance with applicable requirements of Section 33 30 00 "Microtunneling."

3. Variations in diameter, size, shape, wall thickness, reinforcement, placement of reinforcement, laying length, and the permissible underrun of length shall be in accordance with the below listed tolerances or applicable ASTM standards for each type of pipe, whichever is more stringent:

a. Length: Actual laying length shall be plus one (+1) to minus four (-4) inches of the design length.

b. Roundness: Within 0.1% of the design outside diameter.

c. End Squareness: Pipe ends shall be perpendicular to the pipe axis in accordance with ASCE 27-17, Table A.4-1.

d. Straightness: Within 1/8 inch over ten feet.

e. Wall Thickness: Minimum wall thickness shall be the stated design thickness. Wall thickness for jacking pipe shall include a minimum factor of safety of 2.5 on the jacking load determined by the Contractor as required herein.

B. Joints:

1. Except as modified herein, joints shall conform to Section 8 of ASTM C361 and shall consist of a steel spigot and bell and an O-ring type rubber gasket.

2. All surfaces of steel joint rings exposed in finished pipe shall be protected against corrosion by a shop-applied coat of universal primer or by a coating of metallic zinc at least 0.004-inch thick applied by the metalizing process.

3. Steel bell-and-spigot joint rings shall be welded to the longitudinal reinforcing steel or anchored with at least six (6), 1/2 inch diameter bars, 24 inches long, welded to the joint rings.

4. The distance from the face of the spigot to the shoulder of the spigot shall be at least 3/8 inch greater than the joint depth (the distance from the face of the bell to the seat of the bell) for 42 inch and smaller pipe, and at least 1/2 inch greater than the joint depth for pipe larger than 42 inches in diameter.

5. Pipe sections connecting to manholes shall have a joint in each line within 4 feet of the inside face of each manhole or other structure.

C. Reinforcement:

1. Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement will not be acceptable. The total area of longitudinal steel shall be at least 0.2 percent of the concrete cross-sectional area of the pipe. Longitudinal steel shall be spaced uniformly around the pipe and shall consist of at least eight continuous or lap spliced wires or bars (20 bar diameters for deformed bars or 40 bar diameters for smooth bars) in each cage; splices shall not be welded.

3.00 EXECUTION

3.01 PIPE INSTALLATION, HANDLING, AND JOINTING

A. Install 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, ASCE/CI 27-17 and ASTM C76.

B. For pipe to be installed by microtunneling/pipe jacking methods, pipe installation shall also be in accordance with Section 33 30 00 "Microtunneling."

C. For pipe to be installed by open cut methods, trenching, backfilling, and embedment for pipe shall also be in accordance with the requirements of Section 31 23 33.19 "Trenching and Backfill [Plant Construction]" and the following requirements:

1. Furnish and place in position the necessary batter boards, string lines, plummets, graduated poles, etc., laser equipment, targets, and incidentals for establishing and maintaining the lines and grades. The batter boards and location stakes must be protected from possible damage or change of location.

2. Lay pipe and fittings and joint in a dry trench. Excavate trenches to the lines, grades, and alignment indicated in accordance with Section 31 23 33.19 "Trenching and Backfill [Plant Construction]." Unless otherwise authorized by the Engineer, start the laying the pipe on the prepared foundation at the outlet or downstream end with the spigot or tongue end of the pipe joint pointing downstream and proceed with laying pipe toward the inlet or upstream end with each abutting section of pipe properly matched, true to the established lines and grades. Approved facilities shall be provided for hoisting and lowering the sections of pipe into the trench without disturbing the prepared bedding foundation or the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed in the trench. As each length of pipe is laid, protect the open end and prevent the entrance of earth or bedding material. Fit and match the pipe so that when laid in the prepared bedding it forms a smooth, uniform conduit. Remove and re-lay, without extra compensation, pipe that is not in alignment or that shows excessive settlement after laying.

3. Furnish and install shop or field fabricated wyes, tees, crosses, or bends where indicated or designated by the Engineer. Fittings in which the largest pipe is less than 24 inches in diameter shall be shop-fabricated. Fittings in which the larger pipe is 24 inches in diameter or increasingly larger in size, may be field-fabricated. Care shall be taken in the fabrication that the concrete walls of the pipe are broken back only enough to provide

the required finished opening. Join the reinforcing mesh or bars in each pipe by bending, twisting, or spot welding. Wipe concrete or mortar over the reinforcing wires connecting the two pipe joints, compact by light blows, shape to the contour of the pipe barrels, lightly brush finish, and cure under wet burlap.

D. Pipe shall be installed to the lines and grades indicated.

E. Each joint of pipe must be inspected immediately prior to being lowered into the excavation. If repair of damaged areas and holidays is permitted by Engineer, repair those areas per the pipe manufacturer's recommendations before the pipe is lowered into the excavation.

F. Install pipe as specified. Pipe installation methods will be subject to the acceptance of the Engineer. Pipe must be lowered into the excavation using textile slings. Chains or cables shall not be used for handling the pipe.

G. Do not damage the gaskets or the ends of the pipe joints. Prior to connecting the joints, inspect and verify that the pipe ends and gaskets are thoroughly clean with no foreign materials adhering to them. Make joints using cold-applied preformed plastic gaskets as follows:

1. Apply with brush a suitable primer of a type recommended by the gasket joint sealer manufacturer to the tongue and groove joint surfaces and the end surfaces and allow to dry and harden. Do not apply primer over mud, sand, or dirt, or sharp cement protrusions. Clean and dry surfaces prior to application of primer.

2. Before laying the pipe in the trench, attach the plastic gasket sealer around the tapered tongue or tapered groove near the shoulder or hub of each pipe joint. Remove the paper wrapper from one side only of the two piece wrapper on the gasket and press it firmly to the clean, dry pipe joint surface. Do not remove the outside wrapper until immediately before pushing the pipe into its final position.

3. When the tongue is correctly aligned with the flare of the groove, remove the outside wrapper on the gasket and pull or push the pipe home with sufficient force and power (back hoe shovel, chain hoist, ratchet hoist, or winch) to cause the evidence of squeeze out of the gasket material on the inside or outside around the complete pipe joint circumference. Remove any joint material that pushed out into the interior of the pipe that would tend to obstruct the flow. (Pipe shall be pulled home in a straight line with all parts of the pipe on line and grade at all times.)

4. Assemble the pipe with sufficient force necessary to make a tight seal on the gasket. Extreme caution shall be taken by the Contractor so as not to damage the pipe. Do not exceed the forces recommended by the manufacturer for joining the pipe. For pipe to be installed by microtunneling/pipe jacking methods, do not exceed the jacking forces recommended by the manufacturer and as required by Section 33 30 00 "Microtunneling".

5. Check joints with a feeler gauge. If any irregularity in the position of the gasket is detected at any point on the entire circumference of the pipe, remove the pipe and examine the gasket for cuts. If the gasket is undamaged, it may be used again, following the manufacturer's recommendations. After the pipe section is joined, check the line and grade.

6. The maximum deflection of any joint may not exceed 75 percent of the manufacturer's maximum recommended joint deflection.

7. When the atmospheric temperature is below 60 F, store plastic joint seal gaskets either in an area warmed to above 70 F, or artificially warmed to this temperature in a manner satisfactory to the Engineer. Apply gaskets to pipe joints immediately prior to placing the pipe in the trench, then make connections to previously laid pipe.

8. Backfilling of pipe installed by open cut methods and laid with plastic gasket joints may proceed as soon as the joint has been inspected and approved by the Engineer. Take special precautions in placing and compacting backfill to avoid damage to the joints.

H. Protection: Protect pipe from damage before, during, and after installation until backfill or grouting is complete. Protect the Work and materials of other trades. In event of damage, make all necessary repairs and replacements as recommended by the pipe manufacturer at no additional cost to the Owner.

3.02 GROUTING

A. For pipe installed by microtunneling/pipe jacking methods, contact grouting shall be performed after each drive is completed in accordance with Section 33 23 24 "Contact Grouting."

3.03 FIELD QUALITY CONTROL

A. Conduct pipe testing as outlined below.

B. Infiltration/Exfiltration Test:

1. Perform infiltration/exfiltration tests after installation. The Contractor shall perform an infiltration test when pipes are installed below the ground water level.

2. For exfiltration tests, the length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2 feet or 2 feet above the current ground water level, whichever is higher.

3. Plug the pipe with pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.

4. Continue the test for 1 hour. For exfiltration tests, make provisions for measuring the amount of water required to maintain the water at a constant level during this period. For infiltration tests, determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and locations are subject to the Engineer's acceptance.

5. Determine the maximum allowable infiltration or exfiltration rate by the following formula:

$$L = \frac{C \times D \times S}{126{,}720}$$

Where L is the allowable infiltration or exfiltration rate in gallons per hour; S is the length of pipe tested in feet; D is the nominal diameter of the pipe in inches; C is the infiltration or exfiltration rate. Use a value of 50 for C for pipe installed outside of the

25-year floodplain, and use a value of 10 for C for pipe installed within 25-year floodplain.

6. Pipe with visible infiltration or exfiltration, or pipe that exceeds the maximum allowable infiltration or exfiltration rate herein is considered defective and must be corrected by performing repairs as recommended by the pipe manufacturer.

C. Air Test for Individual Joints:

1. Pipe 36 inches in diameter and larger shall be tested at individual joints as recommended by the manufacturer. Each joint shall be tested unless otherwise acceptable to the Engineer.

2. Unless otherwise recommended by the manufacturer, the shortest allowable time for the test pressure to drop from 3.5 pounds per square inch (gauge pressure) to 2.5 pounds per square inch (gauge pressure) is 10 seconds for all pipe sizes.

3. Pipe joints that exceed the maximum allowable pressure drop over a specific period of time as recommended by the manufacturer or herein are considered defective and must be corrected by performing repairs as recommended by the pipe manufacturer.

D. Engineer may require additional performance tests of the joints.

E. Contractor shall not enclose or cover any Work until inspected and required testing has been completed and accepted by the Engineer.

END OF SECTION

33 05 05.31 HYDROSTATIC TESTING

1.00 GENERAL

1.01 WORK INCLUDED

A. Hydrostatically test new pipe between valves or plugs at the pressure and for the duration specified.

B. Additional plugs may be installed to reduce the length of each test section. No additional compensation will be paid if additional plugs are used.

C. Provide a pressure reducing backflow preventer and all temporary piping, pumping, fittings and gauges required to fill, test and then drain the pipe.

D. Do not begin test until pipe has been backfilled for at least 7 days.

1.02 SUBMITTALS

A. Submit detailed hydrostatic test procedure 10 days prior to conducting the test.

B. Submit Hydrostatic Pipe Test Reports per Section 01 33 00 “Document Management.”

1.03 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ASTM International (ASTM):

ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

2. American Water Works Association (AWWA):

AWWA C200	Steel Water Pipe, 6 In (150 mm) and Larger
AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C604	Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA M9	Concrete Pressure Pipe
AWWA M11	Steel Pipe – A Guide for Design and Installation
AWWA M23	PVC Pipe – Design and Installation
AWWA M41	Ductile-Iron Pipe and Fittings
AWWA M55	PE Pipe – Design and Installation

2.00 PRODUCTS

2.01 WATER FOR TESTING

A. Obtain water for filling and testing the pipeline and provide all temporary pumps and piping necessary to fill the pipeline.

B. If chlorinated water is used, then dechlorinate it before disposal per all regulations.

2.02 TEST PLUGS

A. Design plugs or blind flanges to withstand the test pressure on either side with only atmospheric pressure on the opposite side.

B. Provide a 30-inch access manhole in one side of the plug and a 12-inch flanged outlet on the other side of the plug unless shown differently on the Drawings.

3.00 EXECUTION

3.01 GENERAL

A. Perform hydrostatic test in accordance with this Section, AWWA Standards, AWWA Manuals, and the supplier's recommendations.

3.02 TEST PRESSURE

A. The hydraulic grade line shall be 80 feet msl.

3.03 TEST PREPARATION

A. Fill pipe at 0.5 feet per second in the main pipe.

B. Verify all air valves are working and air is vented from temporary taps. Plug taps after test.

C. Allow cement mortar lined pipe to sit with a slight pressure for 48-hours before beginning test.. Add as much water as necessary to maintain the test pressure unless there is an obvious leak that must be fixed.

D. Examine bulkheads, valves, manholes, flanges, and connections for leaks during this period. Stop any leaks before continuing.

E. If an existing valve is in the test section, then coordinate with the Construction Manager to determine an approved method for measuring any leakage past the valve. Furnish all necessary equipment and include the cost for this effort in the Contract Price.

3.04 TEST DURATION

A. Test the test section for 4 hours.

3.05 EXAMINATION UNDER PRESSURE

A. Protect the gauge from direct sunlight during the test.

B. Inspect the pipe during the test to locate any leaks or breaks, defective joints, cracked or defective pipe, fittings, or valves. Correct defective Work identified during the pressure test.

C. Correct all identified leaks even if leakage is within the parameters for permissible make up water per Paragraph 3.06.

D. Test the pipe again after defective Work has been corrected. Repeat the test and correction of defective Work until satisfactory test results are obtained.

3.06 PERMISSIBLE MAKEUP WATER

A. If using welded steel pipe:

1. Makeup water is not allowed for HDPE. The test is acceptable if the pressure drops no more than 5 percent during the test phase. Retest the pipeline, after allowing it to relax for 8 hours, if the pressure drops more than 5 percent.

2. No makeup water is allowed for welded steel pipe. Retest if the pressure drops more than 5 psi during the test.

B. If using ductile iron pipe:

1. Measure make up water. Make up water is the amount of water added to the test section to maintain the pressure within 5 psi of the specified test pressure.

2. The maximum acceptable volume of makeup water for gasketed pipe is 3 gallons per inch of pipe diameter per mile of pipe tested per day.

3.07 CORRECTIONS OF DEFECTS

A. Repair any defective joints, cracked or defective pipe, fittings, or valves discovered in performance of this pressure test with sound material meeting the requirements of the Contract Documents and repeat the test until satisfactory results are obtained. Repair all noticeable leaks even if the actual leakage is within the allowable limits.

3.08 REMOVAL OF TEST PLUGS

A. Remove test plugs once both sides of the pipeline have been tested. If another contractor may need the plug, then coordinate with them – the last contractor to need the plug shall remove it and repair the mortar lining.

END OF SECTION

33 11 13.13 STEEL PIPE AND FITTINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to install steel pipe, fittings, and specials as specified, including connections, and appurtenances, as required for the proper installation and function of the pipe as indicated herein.

B. The pipeline coating shall be in accordance with Section 09 97 16 “Pipeline Coatings and Linings.” The coating shall be polyurethane unless the use of mortar-coated or epoxy-coated steel pipe is indicated on the Drawings.

C. The pipeline shall be suited to carry raw water with some suspended solids.

1.02 QUALITY ASSURANCE

A. Experience Requirements:

1. Pipe shall be the product of one manufacturer who has had not less than 5 years of successful experience manufacturing pipe of the type and size indicated. Pipe manufacturing operations (fabrication of pipe and fittings, lining, and coating) shall be performed at one location unless otherwise approved by the Engineer. The lining and coating for the pipe or the fitting shall be done at the same location as the manufacture of the pipe or fittings. The pipe and fittings may be manufactured at different locations. The Engineer will waive the requirement for 5 years of experience in manufacturing of the pipe when, at the sole discretion of the Engineer, the manufacturer’s experience and capabilities meet the intent of the experience requirement. 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.

2. The lining for pipe diameters 108 inches and smaller shall be shop-applied, spun cement mortar lining per Section 09 97 16 “Pipeline Coatings and Linings.”

3. The manufacturer shall be certified under Steel Pipe Fabricators Association (STI/SPFA) or ISO 9001 quality certification program for steel pipe and accessory manufacturing.

4. Approved manufacturers are:

a. Thompson Pipe Group.

b. Northwest Pipe.

c. American Spiralweld.

B. Testing and Inspection:

1. Pipe may be subject to inspection by an independent testing laboratory selected and retained by the Owner. Representatives of the laboratory or 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 Owner, in writing, a minimum of 2 weeks prior to the pipe fabrication so that the Owner may advise the manufacturer as to the Owner's decision regarding tests to be performed by an independent testing laboratory. Material, fabricated parts, and

pipe which are discovered to be defective and/or do not meet the Specifications shall be subject to rejection at any time prior to Owner's final acceptance of the product. Pipe manufacturer shall be responsible for repairs to the polyurethane coating system that are required as a result of Owner testing at no additional cost to the Owner.

2. The inspection and testing by the independent testing laboratory anticipates that production of pipe shall be done over a normal period of time and without "slow-downs" or other abnormal delays. In the event that an abnormal production time is required, and the Owner is required to pay excessive costs for inspection, then the Installation Contractor shall reimburse the Owner for costs over and above those which would have been incurred under a normal schedule of production as determined by the Engineer.

C. Factory Testing: The manufacturer shall perform all tests as required by the applicable AWWA standards and as listed herein.

D. Cement Mortar Lining: Shop-applied cement mortar linings shall be as specified in Section 09 97 16 “Pipeline Coatings and Linings” and tested in accordance with AWWA C205.

E. Pipe Coatings: Pipe coatings shall be as specified in Section 09 97 16 “Pipeline Coatings and Linings.”

F. Hydrostatic Pressure Testing:

1. Each joint of pipe shall be hydrostatically tested prior to application of lining and 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 recording pressure gauge and reference number of pipe tested, at a minimum. The pipe shall be numbered in order that the pressure gauge information can be recorded.

2. Fittings shall be fabricated from hydrostatically tested pipe. Fittings shall be tested by hydrostatic test, air test, ultrasonic, or magnetic particle test. Air test shall be made by applying air to the welds at 40 psi pressure and checking for leaks around and through welds with a soap solution. In addition, 10 percent of welds shall be checked with x-ray or ultrasonic testing by a third party Certified Welding Inspector paid for by the Owner.

G. Charpy V-Notch Test: Each heat of steel for plates or coil used for pipe barrels 1/4 inches and thicker shall be tested to verify minimum full-size impact values of 25 ft-lb at 30 F in accordance with ASTM A370. Minimum Charpy values for sub size samples shall be defined by ASTM A370.

H. Elongation: For the tensile test specified in ASTM A370, 2-inch test specimens shall show elongations not less than 22 percent for each heat of steel. When 8-inch test specimens are used in lieu of 2-inch test specimens, the specimens shall show elongations not less than 18 percent for each heat of steel.

I. Mill Certification: The Owner will require the manufacturer to furnish mill test certificates on reinforcing steel or wire, steel plate, steel coil, and cement. The manufacturer shall perform the tests described in AWWA C200 for all pipe, fittings, and specials.

J. Manufacturer's Technician 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 as necessary in pipe laying and pipe jointing. The technician shall assist and advise the Installation Contractor in his pipe laying operations and shall instruct construction personnel in proper joint assembly and joint inspection procedures. The technician is not required to be on-site full time; however, the technician shall be on-site during the first 2 weeks of pipe laying and thereafter as requested by the Engineer, Owner, or Installation Contractor.

2. The pipe manufacturer shall provide the services of a representative from both the polyurethane coating manufacturer and the heat-shrink sleeve manufacturer, for a period of not less than 1 week at the beginning of pipe laying operations. Representatives shall advise the Installation Contractor and Owner regarding installation, including but not limited to, handling and storage, cleaning and inspecting, coating repairs, field-applied coating, heat-shrink sleeve installation procedures, and general construction methods and how they may affect the pipe coating.

3. The manufacturer's representative shall be required to return if, in the opinion of the Engineer, the polyurethane coating or the Installation Contractor's construction methods do not comply with the Specifications. Cost for the respective manufacturer's representative to return to the Site shall be at no additional cost to the Owner.

K. Welders and Welding Operations:

1. Shop Welders: Qualified by testing in accordance with ASME BPVC Section IX or AWS D1.1.

2. Field Welders: Qualified by testing in accordance with AWS D1.1.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Shop Drawings:

a. Prior to the fabrication of the pipe, submit fabrication and laying drawings to the Engineer which shall include:

1). Schematic location; including a profile and a tabulated layout schedule, both of which shall reference the stationing shown on the plan and profile sheets.

2). Any deviation from the Drawings necessary to avoid conflicts with existing utilities and structures. The specific number of each pipe and fitting, location of each pipe, and direction of each fitting in the pipeline shall be depicted.

3). Full details of reinforcement and dimensions for pipe and fittings.

4). Location of all outlets as required by the Installation Contractor to install welds.

5). Location and details for the fabrication of all fittings and specials. The line layout shall include the pipe station and invert elevation at all changes in grade or horizontal alignment.

6). Provisions for thrust restraint, external loading, bedding, and vacuum collapse.

7). Welding requirements, welding procedures, provisions for thermal stress control, and provisions for control of coating damage for locations where welded joints are required.

8). Provide details and design calculations for fittings, specials, closures, outlets, joints, and special requirements for pipe in tunnels.

9). Provide certification for gasket joints, indicating it is designed to meet AWWA Standards and these documents.

10). 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, signed, and sealed be a professional engineer licensed in the state the Project is located in.

11). Shop and Field Welding Data:

a). On a weld map, show the location, type, size, and extent of welds, with reference called out for Welding Procedure Specification (WPS) and non-destructive examination (NDE) numbers in tail of welding symbols, in accordance with AWS 2.4.

b). Submit welding terms and definitions in accordance with AWS 3.0.

c). Indicate by welding symbols or sketches, details of welded joints, and preparation of base metal.

d). Distinguish between shop and field welds.

e). Submit welding data together with Shop Drawings as a complete package.

12). Flanged Joints:

a). For each flanged connection, provide: reference standard; dimensional data; bolt hole number, pattern, and diameter; bolt diameter and length; and face condition.

b). Gaskets and Bolting: Technical data sheets itemizing chemical composition, and technical and performance information that indicates compliance with this Specification.

c). Installation: Provide installation instructions including recommended bolt tightening sequence, torque, lubricant, and gasket.

2. Certification of Compliance with Contract Documents: Prior to shipment of the pipe, submit an affidavit certifying that the pipe, fittings, specials, and other products and materials furnished, comply with the Specifications and Drawings, NSF 61 and the applicable requirements of the AWWA standards.

3. Certified Test Reports:

a. Submit the following Certified Test Reports prior to shipment of the pipe:

1). Results of factory hydrostatic tests and test of fittings.

2). Mill certificates; including chemical and physical test results for each heat of steel, Charpy v-notch tests, and elongation tests.

3). From the coating manufacturer, indicating that the coatings were applied in accordance with manufacturer's requirements and in accordance with the Specifications on all pipe, fittings, and joints made in the factory.

4). Welder Qualifications Records (WQR) in accordance with AWWA C206, ASME BPVC Section IX, or AWS D1.1 as required for both factory and field welders.

5). Cement mortar tests.

6). Gasket certification, in accordance to AWWA C200, shall be provided where bell and spigot gasket joint pipe is specified.

7). All manufacturer's factory quality control tests.

4. Record Data:

a. Prior to fabrication, submit the following:

1). Inspection procedures to be used by manufacturer for quality control and assurance for materials and welding.

2). Standard repair procedures that describe in detail shop and field work to be performed.

3). Certification showing calibration within the last twelve months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by Owner.

b. Prior to pipe delivery, submit "Release for Manufacture" layout sheets.

c. Daily welding reports for field welding showing welder and joint welded shall be submitted monthly. Indicate welder's name, joint welded with identification number assigned to match lay drawings.

d. After construction, the pipe manufacturer shall provide AutoCAD drawings of the pipe plan and profile layout sheets showing each joint of pipe and all appurtenances to the same coordinate system as used on the Drawings.

1.04 STANDARDS

A. Except as modified or supplemented herein, the steel pipe, coatings, fittings, and specials shall conform to the applicable requirements of the following standard specifications, latest edition:

1. American National Standards Institute (ANSI) / NSF International (NSF):

a. ANSI/NSF 61 — Drinking Water System Components – Health Effects.

2. American Society of Civil Engineers (ASCE):

a. MOP 79 — Manual of Practice: Steel Penstocks.

3. American Society of Mechanical Engineers (ASME):

    a. BPVC-IX — Boiler and Pressure Vessel Code: Section IX – Welding, Brazing, and Fusing Qualifications.

4. ASTM International ASTM:

ASTM International (ASTM)	
ASTM A193	Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A307	Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A563	Specification for Carbon and Alloy Steel Nuts
ASTM C33	Specification for Concrete Aggregates
ASTM C35	Specification for Inorganic Aggregates for Use in Gypsum Plaster
ASTM C150	Specification for Portland Cement
ASTM D16	Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D522	Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D1000	Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM E165	Practice for Liquid Penetrant Examination for General Industry
ASTM E709	Guide for Magnetic Particle Testing
ASTM E1444	Practice for Magnetic Particle Testing
ASTM F436	Specification for Hardened Steel Washers

5. American Welding Society (AWS):

American Welding Society (AWS)	
AWS B2.1	Specification for Welding Procedure and Performance
AWS D1.1	Structural Welding Code – Steel

6. American Water Works Association (AWWA):

American Water Works Association (AWWA)	
AWWA C200	Steel Water Pipe 6-Inch and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4-Inch and Larger – Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service – Sizes 4-Inch Through 144-Inch

American Water Works Association (AWWA)	
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	Liquid-Epoxy Coating and Linings for Steel Water Pipe and Fittings
AWWA C216	Heat Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipelines in Place – 4-Inch and Larger
AWWA C604	Installation of Buried Steel Water Pipe – 4-Inch and Larger
AWWA M11	Manual: Steel Pipe – A Guide for Design and Installation

7. Society for Protective Coatings (SSPC):

Society for Protective Coatings (SSPC)	
SSPC-SP1	Solvent Cleaning
SSPC-SP2	Hand Tool Cleaning
SSPC-SP3	Power Tool Cleaning
SSPC-SP10	Near-White Blast Cleaning
SSPC-PA2	Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC-PA Guide 10	Guide to Safety and Health Requirements

1.05 DELIVERY AND STORAGE

A. Packing:

1. The pipe shall be prepared for shipment to afford maximum protection from normal hazard of transportation and allow pipe to reach the Site in an undamaged condition. Pipe segments damaged in shipment that require more than two repairs per segment will not be accepted at the Site. No more than 10 percent of all segments shall have damage repairs or all damaged pipe segments will be rejected. Normal factory repair of lining and coating for fabrication of fittings and specials is acceptable.

2. Pipe sections shall be handled in accordance with Paragraph 3.01.C. 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 so that 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.

4. 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 approximately over stulling. Store pipe on padded skids, sand or dirt berms, tires, or other suitable means to protect the pipe from damage. Each end and middle of each length of pipe, fitting, or special shall be internally supported and braced with stulls to maintain a true circular shape. Stulling shall meet the following requirements:

    a. Install stulling in 36-inch and larger pipe, specials, and fittings in accordance with approved submittal and as soon as practical after pipe is fabricated or for shop-lined pipe after lining has been applied. Six-point stulls shall be equally spaced circumferentially (approximately 60-degree spacing) within the pipe. Additional stulls shall be included, as determined by the pipe manufacturer, to protect the pipe from damage. The pipe manufacturer's stulling shall meet or exceed the standards listed in ASCE MOP No. 79.

    b. Pipe shall be rotated so that one stull remains vertical during storage, shipment and installation.

    c. Stulls shall not be removed until pipe is laid, set to grade, and backfilled.

    d. Internal stulls shall consist of timber or steel, firmly wedged and secured so that stulls remain in place during storage, shipment, and installation. Timber stulls will be allowed in diameters above 84 inches, if it can be demonstrated that the timbers will stay in place until backfilling. All timber for stulls must be cured wood. Vertical stull shall be 4-inch by 6-inch timber (min.), Cross stulls shall be 4-inch by 4-inch timber (minimum). Connect stulls with bolts. Shim as needed to maintain tight fit and roundness of pipe.

    e. Install stulling in a manner that will not harm lining. Pipe and liner shall be protected from damage from stulls using wood pads, or similar devices, unless it can be demonstrated that the wood pads are not required to prevent damage to the pipe lining. Pad shall be shaped to conform to pipe diameter. Pad shall be 4-inch by 6-inch timber and a minimum of 18 inches in length.

    f. Stulls shall not be welded directly to the pipe, except at the end of the pipe where the mortar is held back.

B. Marking for Identification:

1. Each joint of pipe, fitting, and special shall have plainly marked on one end of the exterior: the class for which it is designed, the date of manufacturer, and the identification number as shown on the Shop Drawings. Beveled pipe shall be marked with the amount of bevel. The top centerlines shall be marked on all fittings and specials.

2. Each joint of pipe, fitting, and special shall also be marked at each end on the interior lining, near but not inside the bell or spigot, with the section designation and pipe identification number as shown on the approved Shop Drawings. Markings should be visible from inside the pipe after installation, during and after field welding, joint grouting, and inspection. Markings should be applied a minimum of 3 inches in height with a waterproof paint or dye resistant to fading due to UV exposure.

C. Point of Delivery: Whenever possible, pipe shall be hauled directly from the manufacturing plant to the Site and strung along pipeline route, avoiding re-handling and the possibility of damage to the pipe. Where a fully loaded truck and trailer cannot operate along the pipeline route, pipe may be unloaded at access points along the route and brought to the trench side by approved methods; however, the Installation Contractor shall be responsible for pipe being undamaged at the time of installation.

2.00 PRODUCTS

2.01 MATERIALS

A. Flanges, Nuts, Bolts, and Gaskets: Furnish and install all bolts, nuts, flange gaskets, and insulation kits.

1. Flanges shall conform to the AWWA C207 class equal to or greater than the pipe class, unless otherwise specified, and shall match the class of valves or appurtenances which are attached.

2. All nuts, bolts, and washers exposed inside buildings or vaults shall be steel and coated in accordance with the specifications for adjacent pipe. All bolts shall be long enough that a minimum of three threads are exposed beyond the nut. Use an anti-seize compound during installation. Bolts shall conform to ASTM A193, Grade B7. Nuts shall conform to ASTM A194, Grade 2H heavy hex nuts. Washers shall conform to ASTM F436.

3. All buried nuts, bolts, and washers shall be Type 316 stainless steel of suitable strength to meet the service requirements. Bolts shall conform to ASTM A193, Grade B8M. Nuts shall conform to ASTM A194, Grade 8M. Washers shall conform to ASTM A193. All bolts shall be long enough that a minimum of three threads are exposed beyond the nut. Use an anti-seize compound during installation.

4. Non-Insulated Flange Gaskets:

   a. For working pressures up to 175 psi, gaskets shall be rubber.

   b. For working pressures above 175 psi, gaskets shall be non-asbestos compressed fiber.

   c. Gasket configuration shall be in accordance with AWWA C207. Gasket shall be NSF 61 certified. Acceptable manufacturers are Gasket Resources, Garlock, or approved equal.

5. Flange Insulating Kits:

   a. Flange insulating kits shall be installed within 6 months of the date of manufacture of all components.

   b. Do not store insulating flange gaskets, sleeves, or washers under direct sunlight or at temperatures exceeding 110 F.

   c. Insulating gaskets shall be full-face, Type E with an EPDM O-ring seal. Minimum total gasket thickness shall not be less than 1/8 inch. The gasket shall have the same outside diameter as the pipe flange. For steel pipe the gasket's inside diameter shall be equal to the inside diameter of the pipe's steel cylinder. The

complete assembly shall have a pressure rating equal to or higher than that of the joint and pipeline. The gasket material shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline. Insulating sleeves shall be one-piece, full-length, Mylar or NEMA G10 fiberglass reinforced epoxy with a minimum thickness of 1/8 inch.

d. Insulating washers shall be NEMA G10 fiberglass reinforced epoxy.

e. Gasket configuration shall be in accordance with AWWA C207. Gasket shall be NSF 61 certified. Acceptable manufactures are GPT, Houston, TX; or Georg Fischer Central Plastics LLC, Shawnee, OK.

f. Flange bolt holes shall be oversized for bolt insulating sleeves.

B. Steel: Steel shall meet the requirements of AWWA C200 and shall be of continuous casting. Steel shall be homogeneous and shall be suitable for field welding, fully killed, and of a fine austenitic grain size. Steel shall have a minimum yield strength of 42,000 psi.

C. Bend Fittings: All bend fittings shall have a minimum radius of 2.5 times the pipe diameter to permit easy passage of pipeline pigs unless otherwise shown on the Drawings.

D. Threaded Outlets: No threaded outlets will be allowed.

E. Outlets for Weld Leads: Installation Contractor may use factory manufactured outlets for access for weld leads. Outlets shall be welded after use. Outlet configuration shall be shown in the Shop Drawings. Spacing of outlets shall be no closer than 500 feet. Outlets for appurtenances shall be used in the calculation of outlet spacing. Outlet configuration shall be approved by the Engineer.

F. Joint Bonds for Steel Pipe with Rubber Gasket Joints: Bond shall be a solid copper strap, 1-1/4-inch wide by 1/16-inch thick (equivalent to 1/0 AWG wire). Strap bonds shall be manufactured by ERICO Products, Continental Industries, or approved equal. Connection of joint bond to pipe shall be with the thermite weld method using the cartridge and recommended by the bond manufacturer. Additional requirements based on the joint type include:

1. For Coated Steel Pipe: Provide two punched holes for thermite welding to the pipe. Strap bond shall be 12 inches long, maximum. Provide three joint bonds per pipe joint.

2. For Flexible Coupling, Flanged Coupling Adapter, and Other Non-Standard Joints: Provide five punched holes for thermite welding to the coupling and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for 1 inch of joint movement. Provide two bonds per joints for pipe less than 60 inches in diameter and three bonds per joint for pipe 60 inches or greater in diameter.

3. For Insulated Flexible Coupling Joints: Provide four punched holes for thermite welding to the coupling and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for one-inch of joint movement.

G. Flexible Joint Couplings: Shall be as specified in Section 40 05 43 “Miscellaneous Valves.”

H. Cement Mortar Linings: Cement mortar linings shall be shop-applied (plant-spun) for pipe sizes 108 inches and smaller. Shop-applied cement mortar linings shall be provided in accordance with Section 09 97 16 “Pipeline Coatings and Linings.”

I. Epoxy Lining: Where indicated on the Drawings, at all insulating joints, and at all above grade piping provide epoxy lining in accordance with Section 09 97 16 “Pipeline Coatings and Linings.”

J. Epoxy Coating: Where indicated on the Drawings, and for exposed piping, pipe shall have an epoxy coating per Section 09 96 00.01 “High Performance Coatings” and Section 09 97 16 “Pipeline Coatings and Linings.”

K. Polyurethane Coating: Where indicated on the Drawings, and for buried piping, pipe shall have a polyurethane coating in accordance with Section 09 97 16 “Pipeline Coatings and Linings.”

L. Test Bulkheads: Furnish test bulkheads in accordance with the Drawings. Additional test bulkheads not shown in the Contract Drawings but requested by the Installation Contractor shall be paid for by the Installation Contractor.

1. Each test plug or bulkhead shall be designed to withstand the test pressure on either side with only atmospheric pressure on the opposite side. The manufacturer may use either one or two plugs to allow testing on each side.

2. Each test plug or bulkhead specified shall have a 30-inch flanged outlet on each side of the plug. The 30-inch outlets shall be supplied with a 30-inch by 16-inch reducing flange with a 16-inch blind flange. If pipeline diameter is less than 30 inches, the flanged outlet shall match the pipe diameter.

M. Special Coatings in Tunnels and Casings: Pipe to be laid in casing or tunnel shall have a full, continuous mortar coating over the polyurethane coating. The coating shall have at least two mortar bands at a minimum of 2 inches thick, or thick enough to be a larger outside diameter than the bell, including heat shrink sleeve. The mortar coating is to allow the pipe to be installed by skidding on pipe rings. The manufacturer shall design the mortar bands and reinforcement sufficiently to prevent damage to the coating from the installation process.

2.02 MIXES

A. Mortar for Interior and Exterior Joints: Mortar shall be one-part cement to two-parts sand. Cement shall be ASTM C150, Type II. Sand shall be of sharp silica base and shall not leach in water. Sand shall be washed plaster sand meeting ASTM C33. Exterior joint mortar shall be mixed to the consistency of thick cream. Interior joint mortar shall be mixed with as little water as possible so that the mortar is very stiff, but workable. Water for cement mortar shall be treated and suitable for drinking water.

B. Mortar for Pipe Patching for Shop-Applied Cement Mortar Lining: Mortar for patching shall be as per interior joints.

C. Bonding Agent: Bonding agent for cement mortar lining patching shall be a non-shrink cement mortar with a 3:1 sand to cement ratio per AWWA C205.

2.03 MANUFACTURED PRODUCTS

A. Pipe:

1. Pipe Design Criteria:

a. Steel pipe shall be designed, manufactured, and tested in conformance with AWWA C200, AWWA M11, and with the criteria specified herein. Sizes and pressure classes (working pressure) shall be as shown on the Drawings. For pipe design, the transient pressure plus working pressure shall be 1.5 times the working pressure class specified. Fittings, specials, and connections shall be designed for the same pressures as the adjacent pipe. Pipe design shall be based on trench conditions and the design pressure in accordance with AWWA M11 using the following parameters:

Pipe Design Criteria	
Unit Weight of Fill (w)	130 pcf
Live Load	AASHTO HS 20 (at all locations except railroads)
	Coopers E 80 at railroad
Trench Depth	As indicated on the Drawings
Deflection Lag Factor (D_l)	1.1
Coefficient (K)	0.10
Maximum Calculated Deflection ($D_y = D_x$)	2% (polyurethane coated steel pipe) 1% (mortar coated or concrete coated steel pipe)
Soil Reaction Modulus (E')	1500 psi (typical gravel embedment trench section) 3000 psi (where encased in flowable fill or concrete)

b. The fittings and specials shall be designed in accordance with AWWA C208 and AWWA M11, except that crotch plates shall be used for outlet reinforcement for all pressure diameter values (PDVs) greater than 6000. Where indicated on the Drawings, collars or wrappers shall be used in lieu of crotch plates to allow for working space and supports.

c. Where the pipe requires additional external support to meet the specified maximum deflection, the Installation Contractor and the Supplier will be required to furnish alternate methods for pipe embedment. No additional compensation will be made to the Installation Contractor by the Owner where this method is required.

d. 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 be installed deeper than its design allows.

e. Pipe shall be designed for full vacuum conditions without buckling or damage to lining, coating, or pipe joints.

f. The pipe shall be designed for a maximum calculated deflection limit of 3 percent for polyurethane coated steel pipe and 2 percent for mortar/concrete coated steel pipe for any of the following future loadings:

1). Additional fill of 8 feet above the finished grade over the pipeline.

2). A fully loaded Link Belt Hylab 5 crane (150 ton capacity) or equivalent model. The crane will be parked over the pipeline for 2 days, maximum, during repair operations. The design shall assume the worst case scenario for the track orientation. For the purposes of design, the construction load will be considered a live load. This design vehicle translates to a design load in the following table:

Live Loads at the Top of Steel Pipe (lb/lf)									
Nominal Pipe Diameter	Transient Load on Steel Pipe (plf) at Various Covers (ft)								
	4	5	6	8	10	12	14	16	18
36	2900	2500	2200	1700	1500	1300	1100	1000	900
42	3400	2900	2600	2000	1700	1500	1300	1100	1000
48	3900	3400	2900	2400	2000	1700	1500	1300	1200
54	4400	3800	3300	2700	2200	1900	1700	1500	1300
60	5000	4300	3700	3000	2500	2100	1900	1700	1500
66	5500	4700	4100	3300	2800	2400	2100	1900	1700
72	6000	5200	4600	3700	3000	2600	2300	2000	1800
78	6600	5700	5000	4000	3300	2900	2500	2200	2000
84	7200	6200	5400	4300	3600	3100	2700	2400	2200
90	7800	6700	5900	4700	3900	3400	3000	2600	2400
96	8400	7200	6300	5100	4200	3600	3200	2800	2500
102	9000	7800	6800	5500	4600	3900	3400	3000	2700
108	9700	8300	7300	5800	4900	4200	3700	3300	2900

2. Provisions for Thrust:

   a. Thrust at valves, bends, tees, or other fittings shall be resisted by restrained joints. Thrust at bends adjacent to casing shall be restrained by welding joints through the casing and a sufficient distance each side of the casing. No thrust restraint contribution shall be allowed for pipe in casing unless the annular space in the casing is filled with grout.

   b. Restrained joints shall be used a sufficient distance from each side of the valve, bend, tee, plug, or other fitting to resist thrust which develops at the design pressure of the pipe. For the purposes of thrust restraint, design pressure shall be 1.5 times the working pressure class. Restrained joints shall consist of welded joints unless other joint types are specifically shown on the Drawings.

   c. Thrust restraint design shall be the complete responsibility of the pipe manufacturer. The length of pipe with restrained joints to resist thrust forces shall be determined by the pipe manufacturer in accordance with AWWA M11 and the following:

      1). The Weight of Earth shall be calculated as the weight of the projected soil prism above the pipe. Assume the water table matches the ground elevation.

2). Soil Density = 60 pcf buoyant weight.

3). Coefficient of Friction = 0.15 (maximum value to be used for polyurethane coated steel pipe).

4). Coefficient of Friction = 0.25 (maximum value to be used for mortar/concrete coated steel pipe)

5). For horizontal and vertical bends, the length of pipe to be restrained shall be calculated in accordance with AWWA M11.

3. Inside Diameter: The inside diameter, including the cement mortar lining, shall be a minimum of the nominal diameter of the pipe specified, unless otherwise indicated on the Drawings.

4. Wall Thickness:

   a. The minimum pipe wall steel thickness shall be 0.183 inches or Pipe I.D./230, whichever is greater for pipe and fittings. All pipe, fittings, and specials shall have a maximum minus tolerance of 0.005 inches. Where indicated on the Drawings, pipe and fittings shall have thicker steel pipe wall. The minimum steel wall thickness shall also be such that the fiber stress shall not exceed 50 percent of the specified yield strength of the steel, nor the following, at the specified working pressure:

Pipe Type	Maximum Stress at Working Pressure
Polyurethane Coated Steel	23,000 psi
Mortar/Concrete Coated Steel Pipe	18,000 psi

   b. Pipe which is placed in casing or tunnel shall have a minimum pipe steel wall thickness of 0.25 inches or Pipe I.D./144, whichever is greater.

   c. Fittings and pipe that are above grade or exposed (not in a trench, casing, or tunnel) shall have a minimum thickness of 0.25 inches or Pipe I.D./144, whichever is greater.

   d. Pipe, fittings, and specials shall be designed such that the maximum stresses in the pipe due to thrust loading will not exceed 21,000 psi nor 50 percent of the steel yield strength at the thrust design pressure (1.5 times working pressure). Fittings shall meet the requirements of AWWA C208 and AWWA M11.

5. Seams: Except for mill-type pipe, the piping shall be made from steel plates rolled into cylinders or sections, with the longitudinal and girth seams butt-welded; or shall be spirally formed and butt-welded. There shall be not more than two longitudinal seams. Girth seams shall be butt welded and shall not be spaced closer than 6 feet, except in specials and fittings.

6. Joint Length: Maximum joint length shall not exceed 50 feet. Maximum joint length of steel pipe installed in casing shall not exceed 25 feet.

B. Pipe Ends: Pipe ends shall be rubber gasket joint, lap-welded slip joint, butt-strap joint, flanged joint, or flexible-coupled joint.

   1. Rubber Gasket Joints: Rubber gasket joints shall be a rolled spigot joint with rubber gasket for diameters 48-inch and smaller with pressure classes up to 250 psi. Joints shall conform to AWWA C200. The joint shall consist of a flared, bell end formed and sized by

forcing the pipe over a plug die or by expanding on segmental dies. The spigot end shall be an integral rolled groove, steel joint ring in accordance with AWWA C200 and as shown in AWWA Manual M11. The difference in diameter between the I.D. of bell and the O.D. of spigot shoulder, at the point of full engagement and with an allowable deflection, shall be no more than 0.00 to 0.04 inches as measured on the circumference with a diameter tape. The gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to AWWA C200. The joint shall be suitable for 400 psi pressure and a maximum deflected joint pull. Joints shall be of clearances such that water tightness shall be provided under all operating and test conditions with a pipe diameter deflection of 3 percent. At the pipe manufacturer's option, all steel pipe joints may be lap-welded slip joints in lieu of rubber gasket joints.

2. Lap-Welded Slip Joint:

    a. Lap-welded slip joint shall be provided in all locations for pipe larger than 48 inches, 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. Dimensional tolerance of bell and spigots shall be consistent, so that match marking of pipe ends will not be required, and joints are interchangeable in the field. Clearance between the surfaces of lap joints shall not exceed the requirements of AWWA C206.

    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 or three times the thickness of the belled pipe, whichever is greater. 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 may be welded from the inside or outside for pipe diameters 42 inches and larger. All other sizes shall be welded from the outside.

    e. Double welded lap joints and butt strap joints shall be tapped and drilled for testing from the outside in accordance with AWWA C206 and the Drawings.

    f. 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). Band shall be around the outside of spigot end to indicate location at which spigot end has reached required penetration into bell.

3. For Fittings with Flanges: Flanged joints shall be provided at connections to valves and where indicated. Ends to be fitted with slip-on flanges shall have the longitudinal or spiral welds ground flush to accommodate the type of flanges provided. Pipe flanges and welding of flanges to steel pipe shall conform to the requirements of AWWA C207 and AWWA C206. Pipe flanges shall be of rated pressure equal to or greater than the adjacent pipe class. Flanges shall match the fittings or appurtenances which are to be attached. Flanges shall be spot-faced or back-faced parallel to the front face.

4. Flexible Couplings: Flexible couplings shall be provided where shown on the Drawings. Ends to be joined by flexible couplings shall be of the plain-end type, prepared as stipulated in AWWA C200. Pipe ends shall be truly circular to within 1/4 inches or the coupling manufacturer's tolerance, whichever is smaller. In addition, the welds on the pipe ends that are to be joined by couplings shall be ground flush, to permit sliding the coupling in at least one direction to clear the pipe joint. Harness bolts and lugs shall comply with the Drawings.

5. Butt-strap Closure Joints: Where necessary to make closure to pipe previously installed, closure joints shall be installed using butt-strap joints in accordance with AWWA C206 and applicable provisions of this Section. Where butt-strap closure joints cannot be hydrostatically tested in the field with the main pipeline, the butt strap shall have an inside and outside weld and shall be air tested. Air test shall be operated at 5 psi for a minimum of 5 minutes, from a threaded fitting between the welds.

3.00 EXECUTION

3.01 INSTALLATION

A. General:

1. Install steel pipe, fittings, specials, and appurtenances as required for the proper functioning of the completed pipeline. Install pipe, fittings, and specials in accordance with the manufacturer's recommendations, AWWA M11, and AWWA C604. Pipe shall be laid to the lines and grade indicated. Immediately before each joint of polyurethane-coated steel pipe is lowered into the trench, it 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 33.16 "Trenching and Backfill" govern for the excavation and backfilling of trenches for laying steel pipe, fittings, and specials. Conformance with pipe deflection requirements shall be as follows:

   a. Average allowable pipe deflection is limited to 2 percent for polyurethane-coated steel pipe and 1 percent for mortar and shotcrete-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:

$$Percent\ Deflection = \frac{actual\ (plan)\ ID - installed\ (measured)\ ID}{actual\ (plan)\ ID} \times 100$$

   b. Deflection measurements shall be made by the Installation Contractor in the presence of the Owner. Method for taking measurements shall be agreed to by the Owner and Engineer, in writing, prior to installing the first joint of pipe.

   c. The Installation Contractor shall measure deflection approximately 30 days after backfill to final grade. At the beginning of the Project, the first mile of pipe shall be checked 7 days after backfill and again 30 days after backfill. Payment for pipe installation will not be made until pipe deflection is measured, unless otherwise approved by the Owner. No pipe may be measured for compliance prior to fifteen days.

d. The Owner may, at his discretion, perform additional verification measurements on any area prior to Substantial Completion.

e. Average deflection shall be determined by averaging the pipe's measured horizontal and vertical deflection as indicated below. Locations where measurements are taken shall be clearly marked on the interior of the pipe.

f. For pipe joints 36 feet in length or less, measurements shall be taken at two locations, one-quarter distance from each pipe end. Approximately 10 feet from each end.

g. For pipe joints longer than 36 feet, measurements shall be taken at three locations, including one-quarter distance from each pipe end and at the pipe midpoint.

h. If the average calculated deflections for any segment of pipe 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 to the Owner. This may include uncovering the pipe and re-compaction of the pipe embedment, and repair of the coating. It is the Installation Contractor's responsibility to continuously measure and calculate pipe deflection to verify it meets specification. A pipe segment shall be defined as a length of manufactured pipe between manufactured or field-constructed joints.

i. Installed pipe joints will also be examined for flat spots and internal lining stress cracks by the Owner. Lining damage shall be repaired in accordance with the manufacturer's recommendations and as directed by the Engineer, at no additional cost to the Owner. Repair of flat spots may include uncovering the pipe and re-compaction of the pipe embedment, and repair of the coating.

j. Where pipe has been reworked to comply with the deflection requirements, Installation Contractor shall re-measure for deflection no earlier than 7 days after the repaired pipe is backfilled. Owner will re-inspect for flat spots at this time.

k. No pipe installation shall be accepted until the entire installation complies with the above deflection requirements.

3. All costs associated with measuring for pipe deflection and any repairs or rework associated with meeting these requirements shall be borne by the Installation Contractor.

4. Keep the pipe clean during the laying operation and free of sticks, dirt, animals, and trash. 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 Installation Contractor may install a vent at the top of the night 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.

6. Pipe Deflection Reports:

   a. A monthly report shall be submitted as Record Data showing the following for each joint of pipe:

      1). Allowable deflection and 1.5 times allowable deflection for each pipe diameter installed.

2). Deflection measurements and calculated deflection for each location measured per joint.

3). It is the responsibility of the Installation Contractor to verify that the nominal pipe diameter meets specifications at all measured locations. Installation Contractor shall coordinate pipe replacement with the pipe manufacturer for any pipe not meeting the specified internal diameter.

B. Line, Grade and Cover Over Top of Pipe:

1. It is intended that the pipe be laid to the depth specified or shown on Drawings. Cover shall be defined as the distance from the top of the pipe barrel to the natural ground surface. The Installation Contractor shall be required to lay the pipe to conform to the profiles shown on the approved Shop Drawings within 6 inches vertically and 1 foot horizontally.

2. The grades shall be constructed to provide a uniform grade between low points and high points, and intermediate high and low points shall be eliminated. No additional compensation shall be made for extra trench depth required to meet these conditions.

3. Use survey equipment to indicate alignment and grade. Take at least one elevation reading every 50-feet along the pipeline and at horizontal and vertical deflections. Make periodic elevation measurements with surveying instruments to verify accuracy of grades.

C. Pipe Handling: Pipe shall be handled at all times with a minimum of two non-abrasive slings, belts, or other equipment designed 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. The spacing of pipe supports required to handle the pipe shall be adequate to prevent cracking or damage to the lining or coating.

D. 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.

2. All under-stabbed joints shall be butt-strapped or outside welded. Over-stabbed joints shall not be acceptable. A joint shall be considered over-stabbed if the stabbed section is within 2 inches of the tangential bend on the bell, or the inside mortar gap is less than 1/4 inch. All over-stabbed joints shall be either butt-strapped and welded or outside welded only.

3. Where abrupt changes in grade and direction occur, the Installation 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.

4. Where pipe horizontal alignment is on a curve, Installation Contractor may pull joints to make a curved alignment. Pulled joints that are welded shall meet the overlap requirements mentioned above. Pulled rubber gasket joint deflection shall not exceed 75 percent of the manufacturers' recommended allowable deflection.

5. After joining rubber gasket joints, check the position of the gasket with a feeler gauge. If the gasket is out of position, disassemble the joint and repeat the joint laying operation. Upon completion of pipe jointing, the interior of the pipeline shall be left broom clean.

E. Pipe Laying - Rubber Gasket Joints: Join rubber gasket joints in accordance with the manufacturer's recommendations. Clean bell and spigot of foreign material. Lubricate gaskets and bell and relieve gasket tension around the perimeter of the pipe. Engage spigot as far as possible in bell, allowing for a minimum gap of 0.5 inch for inside joint grouting after any joint deflection. Joint deflection or pull shall not exceed 75 percent of the manufacturer's recommended maximum pull. Check gasket with feeler gauge all around the pipe.

F. Pipe Laying – Welded Joints:

1. Weld joints in accordance with the AWWA C206 and AWS D1.1. Installation Contractor shall provide adequate ventilation for welders and for Owner's representative to observe welds. Unless otherwise specified, welds shall be full circle fillet welds. Welding may be completed before application of field-applied joint coating. At his option, the Installation Contractor may weld pipe joints after the exterior joint coating and backfilling is complete. Installation Contractor shall demonstrate that this procedure will not damage the exterior joint coating.

2. Contractor shall submit a welding procedure for approval according to Paragraph 1.03. The welding procedure shall be approved by the Engineer before welding of joints begins. The procedure shall be in accordance with AWWA C206 and AWS D1.1. Contractor must follow approved welding procedure only.

3. Provide a deeper bell every 400 feet to accommodate thermal movement.

4. Adequate provisions for reducing temperature stresses shall be the responsibility of the Installation 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 or tacking to be within the maximum clearance tolerance around the periphery of the joint per AWWA C206. Tighter tolerance may be required to prevent damage to heat shrink sleeves for weld-after-backfill. In no case shall the clearance tolerance be permitted to accumulate.

6. Before welding, thoroughly clean pipe ends to bare metal. Joint shall be dry before welding. All welding shall be hand welded to minimize damage to heat shrink sleeves, unless it can be demonstrated that wire fed welding will not cause unacceptable damage to the heat shrink sleeve. Welding shall be performed so as not to damage lining or coating. Cover the polyurethane coating as necessary to protect from welding.

7. Furnish labor, equipment, tools, and supplies, including shielded-type welding rod, to construct the Work as required in the Contract Documents. Protect welding rod from any deterioration prior to its use. If any portion of a box or carton is damaged, reject the entire box or carton. Contractor will provide and maintain a jacking or fitting tool to minimize the joint gap tolerance of each joint from the pipe interior. This tool shall be adequate to force the bell and spigot joint gap tolerance to 1/8 inch or less. The tool

shall remain with each welding operation to ensure the equipment is readily accessible to the welders and is not overlooked when fitting is required.

8. All welding shall be completed with a minimum of two weld passes. Three passes or more will be required for steel thickness greater than 0.375 inches, and as required to meet the specified welding procedures. These requirements are in addition to the maximum coating temperature limitations.
9. In all welding, the metal shall be deposited in successive passes. 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 to relieve shrinkage stresses and to remove dirt, slag, 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.
10. Welds shall be free from pin holes, non-metallic inclusions, air pockets, undercutting and/or any other defects.
11. 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.
12. 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, his stencil shall be voided and not duplicated if another welder is employed.
13. Keep daily welding reports which identify the welder's name and the joint welded. Joints must be shown on the daily welding reports with the identification number assigned in the lay drawings (ex. ID#1 – ID#2). Provide three copies of all daily welding reports to Owner's representative each month.
14. Use only competent, skilled, and qualified workmen. Each welder employed by the Installation Contractor shall be AWWA C206 and 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. Field welding shall be provided by one of the following firms:
    a. Thompson Pipe Group, (972) 262-3600.
    b. Fuller's Service Company, Barry Fuller, (817) 477-3841.
    c. Scott's Welding, Scott Fowler, (972) 978-7865.
    d. Eddie's Welding Service, Eddie Pierce, (817) 909-6089.
    e. National Welding Corporation, Nash Williams, (801) 255-5959.
    f. Rangeline Pipeline Services, LLC, (888) 722-7457.
    g. Others may be accepted pending approval by Owner or Engineer.
15. After each welder has qualified in the preliminary tests referred to above, inspections shall be made of joints in the line. Any welder making defective welds shall not be allowed to continue to weld.

16. Visual tests and magnetic particle tests in accordance with AWWA C206, ASTM E709, and E1444 shall be performed by the Installation Contractor's independent testing laboratory on all welded joints. Welds that prove to be defective will be replaced or repaired, whichever is deemed necessary by the Engineer, at Installation Contractor's expense. The Installation Contractor shall provide adequate ventilation and a safe environment for welding inspector. Inspections will be made on a weekly or bi-weekly basis as determined by the Owner. The Installation Contractor shall cooperate with the welding inspector to allow efficient inspections.

17. If the Installation Contractor disagrees with the Engineer's interpretation of welding tests, test sections may be cut from the joint for physical testing. The Installation 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.

G. Inside Joint Grouting for Pipe with Shop-Applied Mortar Lining: Upon completion of backfilling of the pipe trench and 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 2 inches or wider, 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.

H. Flanged Joints: Flange bolt torque and sequence shall be determined by the pipe manufacturer in accordance with AWWA C604 and AWWA M11. Use lubricant for threads and washers. 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 and torqued with a suitable, approved, and calibrated torque wrench. Torque values shall be as recommended by the pipe manufacturer. Apply clamping torque to the nuts only.

I. Special Requirements for Weld-After-Backfill:

1. Quality Control:

a. If Installation Contractor elects to weld-after-backfill any joints, special techniques shall be used to limit damage to the exterior heat shrink sleeves. Weld procedures for weld-after-backfill shall meet the heat limitations of the proposed coating system.

b. Each welder shall be required to demonstrate that no unacceptable damage will occur to the heat shrink sleeve. Each welder shall demonstrate their ability to perform welding of the joints in compliance with the welding requirements, including weld profile, penetration depth, travel speed control, and temperature control. The following information shall be recorded for each joint tested:

1). Welder's name.

2). Weld procedure to be used.

3). Voltage setting of the welder.

4). Amperage setting of the welder.

5). Average electrode speed (inches per minute).

6). Calculation of the heat input to the weld, in Joules. Use the following equation:

$$Amperage\ (I) \times Voltage\ (E) \times 60 = Heat\ Input\ Travel\ Speed\ (V)$$

7). Record steel pipe temperature measurements in 11.5-degree increments around the circumference of the joint. Read the temperature using heat stick methods or with a digital infrared thermometer. Record the temperature at the weld immediately following the completion of the weld. Record the temperature at locations 1 inch, 2 inches, and 3 inches from the weld, on either side of the weld, during the welding process.

8). Measure and record the highest interior weld temperature produced during successful weld-after-backfill testing. Measure the temperature at approximately 3 inches below the welding arc concurrent to the welding. Welders shall not exceed this temperature while using this welding procedure.

c. The test joint shall be backfilled and each welder proposed for the Project shall be tested. Tests shall be conducted on prototype test joint with the minimum wall thickness for each type of sleeve used on the Project.

d. Each welder shall provide a complete weld for a minimum of 2 feet of weld overhead and below head.

e. The test joint will be excavated after welding and destructively tested.

1). After welding, a visual inspection of the sleeve will be made to verify there is no unacceptable damage to the exterior heat shrink sleeve and coating protection. Sleeves shall have no visible burns, excessive wrinkles, or holidays. Sleeves shall not have areas of dis-bonded coating or dis-bonding of the heat-shrink sleeve, except for limited carbonization zone.

2). The heat shrink sleeve shall be tested by an adhesion test in accordance with ASTM D1000, AWWA C216, and C222. Test shall meet an adhesion value of 15 lb-inch. Test shall be performed directly over the weld (parallel) and perpendicular to the weld. The sleeve backing shall not rip, tear, split or separate from the adhesive material. The test shall be done a minimum of 24 hours after welding.

3). Demonstration section shall be completely removed and legally disposed of after successful completion of the demonstration, or prior to final acceptance of the Project.

f. Excavate the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation by Installation Contractor for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Should the inspection of the exterior coating reveal damage in the opinion of the Engineer, the test will be considered a failure and the coating will be removed and replaced at no additional cost to the

Owner. The test for the failed welder may be repeated on another joint, with the approval of the Engineer.

g. If any excavated weld-after-backfill joint exhibits any heat related damage, Installation Contractor shall modify and test a new weld-after-backfill procedure prior to completing any additional welded joints. Installation Contractor shall demonstrate that the revised joint welding procedure will not significantly damage the coating by repeating the weld-after-backfill evaluation requirements, including excavation of the three additional joints randomly selected for destructive evaluation.

h. Installation Contractor will remove and replace joint heat shrink sleeve upon completion of the evaluation.

2. Materials:

a. "Weld-After-Backfill" or post-welded joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.

b. Weld-after-backfill joints shall be coated and protected as follows. Approved materials shall be in accordance with Section 09 97 16 "Pipeline Coatings and Linings." Joint coatings shall be heat shrink joint sleeves only. Tape wrapped joints will not be acceptable.

c. Holdback primer shall be suitable for weld-after-backfill conditions. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during weld-after-backfill joints. Primer shall not exhibit binder breakdown in the heat-affected zone. Binder breakdown causes loss of joint coating adhesion to the holdback primer. Tape primers are not allowed.

d. Filler mastic materials shall be high-temperature materials with 500 F minimum melting point.

e. Filler mastic will be Denso North America or Trenton Corporation products.

3. Installation:

a. Installation of heat shrink sleeves shall comply with the requirements of the Specifications and AWWA C216.

b. Joints shall be buried prior to welding, with not less than 12 inches of soil or flowable fill material above the pipe, including side and bottom of trench.

c. Prior to welding, remove hold-back primer from I.D. of bell and O.D. of spigot with a power steel brush to prevent contamination of welds.

d. Welding of the Joints:

1). All welding shall be wire-fed or with stick electrodes. Provide two or more weld passes as required to meet the approved AWS welding procedures and maximum coating temperature limitations. Not more than 1/8 inch shall be deposited per weld pass. Weld-after-backfill procedures must be approved by the Engineer based on field testing demonstrating the welding procedures can comply with the requirements herein and Section 09 97 16 "Pipeline Coatings and Linings".

2). Welding speed, amperage, and voltage shall be as required to maintain a maximum heat input of 23,000 joules or a maximum surface temperature at the coating/steel interface of 500 F, whichever is least.

3). Maximum weld temperature and duration shall not result in significant carbonization of the joint coating adhesive or adversely affect the integrity of the sleeve. Significant carbonization is the loss of volatile organic compounds that results in substantial loss of tackiness, adhesion to the steel, and corrosion protection properties.

4). Finished joint coating shall not have any visible creases or folds in more than 50 percent of the joint coating backing material or that extend through both the inner protective layer and outer joint sleeve. A slight surface deformation of the sleeve may be deemed acceptable if the underlying layers are not compromised beyond slight carbonization.

e. The heat-shrink sleeve shall be electrically tested for holidays per Section 09 97 16 "Pipeline Coatings and Linings."

3.02 PROTECTIVE COATINGS SYSTEM

A. Perform field coating of joints in accordance with Section 09 97 16 "Pipeline Coating and Lining." For weld-after-backfill, heat tolerant heat-shrink joint wrapping and special welding techniques will be used. At the start of the Project, at least one joint of pipe per welder shall be uncovered at no additional cost to the Owner to verify the exterior joint wrap is not damaged. Should a change of materials be required, or a new welder employed, additional test joints may be directed by the Engineer.

B. The Installation Contractor is responsible for ensuring his operations do not damage the factory or field applied coating system.

C. Protection of Buried Metal: Buried ferrous metal such as flanges, bolts, nuts and couplings which cannot be protected with factory or field-applied polyurethane coatings or heat shrink sleeves shall be coated with two wraps of wax tape meeting AWWA C217 as specified in accordance with Section 09 97 16 "Pipeline Coatings and Linings" and encased in flowable fill.

D. Repair of Mortar Lining:

1. Repair lining cracks larger than 1/8 inch in width with approved methods. Pipes with loose and dis-bonded linings will be rejected. Excessive repair of lining shall not be permitted. Apply bonding agent to patch area. Patching of lining shall be allowed where area to be repaired does not exceed 4 square feet and has no dimension greater than 24 inches. In general, there shall be not more than one patch in the lining of any joint of pipe. Patching for the manufacture of fittings and specials is acceptable, and not limited to the maximum square footage described above.

2. Wherever necessary to patch the pipe, make the patch with the mortar indicated. Do not install patched pipe until the patch has been properly and adequately cured and unless approved for laying by the manufacturer's technician and by the Engineer.

3. Shop-applied mortar lined pipe joints requiring patches that exceed the size allowed by 09 97 16 "Pipeline Coatings and Linings" shall be rejected and replaced at no additional

cost to the Owner. The opinion of the Engineer shall be the sole factor in determining the acceptability of the required repair.

E. Quality Control of Field-Applied Polyurethane Coating: See Section 09 97 16 “Pipeline Coatings and Linings.”

F. Pipe Through Vaults: Where piping is to be inside a vault, such as for meters or valves, the vault floor shall be cast, then the piping installed, then the vault walls constructed.

3.03 FIELD QUALITY CONTROL

A. Perform a field hydrostatic test in accordance with Section 33 05 05.31 “Hydrostatic Testing.”

END OF SECTION

33 13 54 GEOTECHNICAL INSTRUMENTATION AND MONITORING

1.00 GENERAL

1.01 SCOPE OF WORK

A. Furnish the required labor, equipment, and materials for installation, monitoring, maintenance, and removal of geotechnical instrumentation for monitoring of movement of the ground surface, movement of structures and utilities, and groundwater adjacent to shaft excavations and along the trenchless alignment during construction.

B. Geotechnical instrumentation includes Surface Monitoring Points (SMPs), Structural Surface Monitoring Points (SSMPs), Utility Monitoring Points (UMPs), and Piezometers (PZ).

C. The Contractor shall perform all monitoring and surveying as required for geotechnical instrumentation. Contractor shall install additional survey benchmarks and control points as necessary.

1.02 RELATED WORK

A. Section 33 23 24 “Contact Grouting.”

B. Section 33 30 00 “Microtunneling.”

C. Section 33 73 15 “Shaft Excavation.”

D. Section 33 73 16 “Groundwater and Surface Water Control.”

1.03 QUALIFICATIONS

A. Qualifications for Instrumentation Specialist: Contractor shall employ a Professional Engineer licensed in the State of Texas to supervise and direct instrument installation as specified herein and as shown on the Drawings. The Instrumentation Specialist shall have sufficient experience in furnishing, installing, monitoring, maintaining, and removing instrumentation.

B. Qualifications for Surveyor: Contractor shall employ a Professional Land Surveyor licensed in the State of Texas with previous similar experience surveying for the detection of movement of the ground surface, structures, utilities, and other facilities. The Surveyor shall supervise and direct Contractor personnel performing readings of instrumentation as specified herein and as shown on the Drawings.

1.04 QUALITY ASSURANCE AND CONTROL

A. All instrumentation shall be installed, and baseline readings shall be obtained no later than 14 days prior to the applicable construction activity, including, but not limited to any shaft or tunnel excavation and/or associated dewatering activities.

B. Contractor shall provide notice to the Engineer not less than 24 hours before installing instrumentation.

C. Instrumentation Supplier: Each type of instrument specified herein shall be the product of an acceptable manufacturer currently engaged in manufacturing instrumentation.

1.05 SUBMITTALS

A. Pre-construction Submittals: Submit to the Engineer the following a minimum of 30 days before the scheduled start of the applicable construction activity, including, shaft or tunnel excavation and/or associated dewatering activities.

1. Qualifications: Submit qualifications of the Instrumentation Specialist(s) and Surveyor(s) in accordance with Article 1.03. herein.

2. Description of methods and materials for installing, maintaining, protecting, and removal of the instruments. Include instrumentation manufacturer's shop drawings, product data sheets, operating manual, installation and calibration instructions, and calibration certifications, as applicable. Also include plan for instrument locations.

3. Draft of all proposed instrumentation reporting forms for recording, reducing, and presenting instrumentation readings and results in both tabular and graphical form, including both manual and/or computerized data reduction methods.

4. Building and Structures Assessment: Perform a detailed pre-construction and post-construction assessment of the existing structures at the Lawson Raw Water Pump Station Site, which includes but is not limited to, the communication tower and associated foundation, pump station forebay basin, and the electrical building. Include photographs and/or video recording of the existing conditions, especially any imperfections or damage to existing structures in vicinity of the proposed excavations.

5. Contingency Plan: Submit a Contingency Plan that defines the remedial measures to be implemented to stabilize the shaft or tunnel excavation if any geotechnical instrumentation readings meet or exceed the response values listed herein. The Contingency Plan is not to restrict the Contractor from using the best construction methods available to meet the conditions but is required a demonstrate a reasonable level of preparedness in the event of movement of ground, structures, utilities, or other facilities. The Contractor shall have appropriate labor, equipment, materials, and other items that are identified in the Contingency Plan available at all times while the shaft and tunnel excavations are open, or any associated dewatering operations are being performed. At a minimum, the Contingency Plan shall include:

a. Name and qualifications of personnel responsible for implementing the Contingency Plan.

b. Description of the scenarios where remedial measures may be required in order to stop or prevent further movement and to protect adjacent structures, utilities, or other facilities as well as a description of the remedial measures.

c. Listing of labor, equipment, and materials to be utilized or implemented for remedial measures described above and their availability.

d. Description of methods used to verify that the remedial measures were successful for each scenario.

B. Construction Submittals: Submit to the Engineer the following items within the time restrictions specified:

1. Installation Records: Within five days of installation of each instrument, the Instrumentation Specialist shall submit drawings showing the installed location, the

instrument identification number, the instrument type, the installation date and time, established elevations, initial elevations, offset and stationing, initial coordinates, and the anchor to tip elevation and instrument length, when applicable. The Instrumentation Specialist shall also furnish details of installed instruments showing all dimensions and materials used, a separate statement describing installation procedures for each instrument, and as-built drawings of each instrument including depths, lengths, elevations and dimensions of key elements. For piezometers, boring logs and piezometer logs shall be submitted if the Contractor elects to install any.

2. Initial baseline readings for all instruments.

3. Data: Provide electronic reports in Microsoft Excel format of data to the Engineer within twenty-four hours after collection of the data unless movement is observed that meets or exceeds the response values herein. If the response value is observed or exceeded, the Contractor shall notify the Engineer immediately as described herein. The data shall include the instrument identification number, location, date and time of reading, initial baseline readings, reference elevations, weather conditions and temperature at time of reading, proximity of the excavation activities to instrument location, project name, project number, and all other pertinent information, or other information as requested by the Engineer. Each data submittal shall include all current and previous readings and time history of excavation activity in both tabular and graphical form acceptable to the Engineer.

4. Calibration Records: Within five working days of performing an instrument calibration or re-calibration, submit results of the calibration to the Engineer.

1.06 SAFETY

A. The Contractor's methods of construction shall ensure the safety of the Work, project participants, the public, third parties, and adjacent property, whether public or private. All Work shall conform to the requirements of all Federal, State, and local laws and regulations. The Contractor is solely and completely responsible for maintaining safe working conditions at the site at all times.

B. For instruments located on the ground surface, in, adjacent to, or near active traffic lanes, appropriate precautionary traffic control and/or diversion measures shall be taken during installation, monitoring, maintaining, and removing of instruments to ensure a safe working environment.

2.00 PRODUCTS AND MATERIALS

2.01 MATERIALS

A. Bentonite: Granular bentonite shall be Enviroplug Medium, as manufactured by Wyo-Ben, Inc., Billings, MT, or Holeplug, as manufactured by Baroid Division, Petroleum Services, Inc., Houston, TX, or acceptable equivalent.

B. Cement Grout: Shall be Type II Portland cement and water in accordance with ASTM C150.

2.02 PRODUCTS

A. Piezometers (PZs) are instruments shown on the Drawings to monitor groundwater.

B. Surface Monitoring Points (SMPs) are instruments shown on the Drawings to monitor movement of the ground surface.

C. Structural Surface Monitoring Points (SSMPs) are instruments shown on the Drawings or described herein to monitor the movement of existing structures and shall include either of the following:

1. 3 inch long by ½ inch diameter stainless steel hex expansion anchor positioned to receive survey rod and anchored into sound concrete, brick, or masonry surface of building façade at 3 feet to 5 feet above grade.

2. Reflective survey targets that are flush or perpendicularly protrude from the surface to which it is affixed. Reflective survey targets shall be manufactured by Berntsen or approved equal. Reflective survey targets shall be installed in accordance with the manufacturer's recommendations.

D. Utility Monitoring Points (UMPs) are instruments shown on the Drawings to monitor movement of existing utilities.

3.00 EXECUTION

3.01 GENERAL

A. Instrumentation Installation: Instrumentation shall be installed by the Contractor at the locations shown on the Drawings, or as otherwise acceptable to the Engineer. Instruments shall be installed in accordance with the instrumentation schedule and details shown on the Drawings, in accordance with the manufacturer's recommendations for the respective instrument, and as described herein. The Contractor may install and monitor additional instrumentation as required by the Contractor, but installation, monitoring, and removal of such additional instrumentation shall be performed at no additional cost to the Owner. Locations of additional instrumentation shall be acceptable to the Engineer.

B. Access: Contractor shall provide and facilitate safe access to the instruments at all times for the Engineer. The Contractor shall allow and facilitate instrument monitoring by the Engineer, for up to a maximum of 30 minutes of interruption per each 8-hour shift. The Engineer may collect or check the readings at any time during construction for quality assurance purposes, but this shall not limit or shift the responsibility of the Contractor for the Work described herein.

C. Existing Conditions: Contractor shall locate conduits and underground utilities in all areas where subsurface geotechnical instrumentation is to be installed. Contractor shall contact "Texas811" prior to any excavation activities.

D. Identification: All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public.

E. Instrument Designation: A unique instrument identification number shall be assigned to each instrument and each point. The instrument identification number shall be clearly marked on each instrument in a permanent, legible, and nondestructive manner.

F. Surveying: Immediately following installation, the location of all instruments shall be surveyed to provide horizontal and vertical coordinates and such data shall be provided to the Engineer. Re-surveying from control points shall be required monthly or more frequently

to address potential disturbance or resolve conflicting data. Monitoring of all instruments and monitoring points shall be per the schedules provided herein.

G. Piezometers (Existing): Existing piezometers shown on the Drawings shall be protected and monitored during construction until construction is complete or until the piezometer is removed to facilitate construction. The Contractor shall obtain authorization from the Engineer prior to removal of any existing piezometers shown on the Drawings.

H. Piezometers (New): The Contractor may install and monitor additional piezometers as required by the Contractor, but installation, monitoring, and removal of such additional piezometers shall be performed at no additional cost to the Owner. Locations of additional piezometers shall be acceptable to the Engineer. Installation of additional piezometers shall be performed by a well driller licensed in the State of Texas and installations shall comply with the Administrative Rules for Water Well Drillers and Pump Installers of the Texas Department of Licensing and Regulation and the applicable rules of the Southeast Texas Groundwater Conservation District.

3.02 MONITORING

A. Initial Baseline Readings: The Contractor shall take initial baseline readings of all instruments to establish a baseline and provide the Engineer with this data, in accordance with the requirements specified herein. The initial baseline readings shall consist of at least three complete sets of separate readings of each instrument. Each separate reading at each instrument shall be taken at least 24 hours apart. The initial baseline readings shall be performed and recorded to the nearest hundredth of a foot.

B. Frequency:

1. The Contractor shall monitor instrumentation and provide the Engineer with the data within the timeframe required herein. As a minimum, the Contractor will follow the following schedule. The “Active Zone” is defined as instrumentation that is within 100 feet of active shaft excavation activities and/or within 100 feet of the face of tunnel excavation. The readings shall be performed and recorded to the nearest hundredth of a foot. Survey benchmarks or survey control points used to obtain readings shall be at least 200 feet away from locations of shaft or tunnel excavation or associated dewatering activities.

Instrument Type	**Active Zone**	**Outside Active Zone**
Piezometers	Daily	Weekly
Surface Monitoring Points (SMPs)	Daily	Weekly
Structural Surface Monitoring Point (SSMPs)	Daily	Weekly
Utility Monitoring Points (UMPs)	Daily	Weekly

2. The Contractor shall perform additional monitoring as necessary or as directed by the Engineer to monitor movement and to ensure the safety of the Work. Additional monitoring, if required, shall be performed at no additional cost to the Owner.

C. Interpretation: The Contractor shall make their own interpretations of the data for their own purposes. Data or interpretations thereof shall not be published or disclosed to other parties without advance written permission of the Engineer. The Engineer may make their own interpretations of the data available to the Contractor at the Engineer's option.

3.03 MAINTENANCE

A. Damaged Installations: Contractor shall protect the instruments from damage. Damaged installations shall be replaced as required prior to continuing excavation, unless otherwise permitted by the Engineer.

B. Maintenance: Maintain the instruments by draining water and flushing debris from under protective covers and keeping covers locked and sealed at all times.

3.04 REMOVAL

A. Prior to final acceptance of the Work and except as otherwise acceptable to the Engineer, the Contractor shall remove and dispose of at least the top three (3) feet of instrument or casing for all instrumentation, including piezometers previously installed by others at locations indicated on the Drawings. Any existing instrumentation that is not specifically indicated on the Drawings shall remain.

B. Existing and any Contractor installed piezometers or dewatering wells shall be plugged by a licensed well driller in the State of Texas and plugging shall be performed in accordance with the Administrative Rules for Water Well Drillers and Pump Installers of the Texas Department of Licensing and Regulation and the applicable rules of the Southeast Texas Groundwater Conservation District. Contractor shall complete and submit a Plugging Report with applicable fees to the Texas Department of Licensing and Regulation as required for the plugging of such piezometers. The Contractor shall provide a copy of the Plugging Reports to the Engineer and Owner.

C. Any surface enclosures, protective bollards, or other appurtenances associated with such instrumentation, shall be removed, and the area at and surrounding the removed instruments shall be restored to previously existing conditions by the Contractor. Contractor shall also repair or patch any pavement that is disturbed or damaged by the Work required herein.

3.05 RESPONSE VALUES

A. The Contractor shall abide by the following Response Values. The Contractor shall utilize whatever means and methods necessary to limit ground, structure, or utility movement, including, but not limited to, underpinning, compaction grouting, and/or consolidation grouting. Such means and methods shall be performed in accordance with industry accepted standards and practices.

Instrument Type	Threshold Value	Shutdown Value
Surface Monitoring Point (SMP)	0.25 Inch	0.50 Inch
Structural Surface Monitoring Point (SSMP)	0.25 Inch	0.50 Inch
Utility Monitoring Point (UMP)	0.25 Inch	0.50 Inch

B. When a given Response Value is reached, the Contractor shall respond in accordance with the following:

   1. Threshold Value: The Contractor shall notify and meet immediately with the Engineer to discuss the Contractor's means and methods to determine what changes, if any, shall be made to better control movement.

   2. Shutdown Value: The Contractor shall stop all work immediately, unless in the event of an emergency, and notify the Engineer. The Contractor shall meet with the Engineer to develop a plan of action that is acceptable to the Engineer for better control of movement before the Contractor may resume work.

C. If movement due to excavation unacceptably damages the ground surface, structures, utilities, or other facilities, the repair and/or replacement of such shall be as required and as directed by the Owner, Engineer, and owner of such property, structure, utility, or other facility. Such repairs or replacements shall be performed by the Contractor at no additional cost to the Owner. If owner of such property, structure, utility, or other facility elects to self-perform the repair or replacement, the Contractor shall reimburse the owner of such property for such repair or replacement at no additional cost to the Owner.

END OF SECTION

33 23 24 CONTACT GROUTING

1.00 GENERAL

1.01 SCOPE OF WORK

A. The Work specified in this section includes requirements for contact grouting of the annulus between the outside face of the jacking pipe and the surrounding ground. Contact grouting shall be performed to displace all remaining slurry, jacking pipe lubricants, and groundwater and fill all voids within the annulus.

B. Contact grouting of the jacking pipe shall be completed within one week of the completion pipe jacking and prior to installation of any carrier pipe, if applicable.

C. All Work specified herein is the responsibility of the Contractor and is subject to the acceptance of the Engineer. All work described herein shall be performed in conformance with the American Society of Civil Engineers ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, and the ASCE AUA Guidelines for Backfilling and Contact Grouting of Tunnels and Shafts, unless otherwise stated herein. In the event of conflict between the guidelines and the requirements herein, the Contractor shall comply with the more stringent requirements.

D. Testing of contact grout materials as required herein shall be performed by an independent testing laboratory acceptable to the Engineer. All coordination of and the costs associated with testing of contact grout required herein shall be the responsibility of the Contractor.

1.02 RELATED SECTIONS

A. Section 33 05 01.07 “Reinforced Concrete Pipe.”

B. Section 33 13 54 “Geotechnical Instrumentation and Monitoring.”

C. Section 33 30 00 “Microtunneling.”

D. Section 33 31 13.13 “Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.”

E. Section 33 73 16 “Groundwater and Surface Water Control.”

1.03 REFERENCES

A. American Society for Testing and Materials:

1. ASTM C31/C31M – Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C33/C33M – Standard Specification for Concrete Aggregates
3. ASTM C39/C39M – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C150/C150M – Standard Specification for Portland Cement
5. ASTM C937 – Standard Specification for Grout Fluidifier for Preplaced Aggregate Concrete

B. American Society of Civil Engineers (ASCE) - ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, 2015.

C. ASCE, AUA Guidelines for Backfilling and Contact Grouting of Tunnels and Shafts, 2003.

D. NSF International/American National Standards Institute (NSF/ANSI) – NSF/ANSI Standard 60: Drinking Water Treatment Chemicals - Health Effects.

1.04 DEFINITIONS

A. Definitions are as stated in ASCE/CI Standard 36-15, Chapter 3 Definitions, unless modified or supplemented herein.

B. Refusal: Refusal associated with contact grouting is when the grout take into the grout port is measured as zero cubic feet per minute over a continuous two-minute period at the maximum allowable injection pressure for the location of the specific grout port.

1.05 QUALITY ASSURANCE AND CONTROL

A. Grouting Supervisor: The Contractor's Grouting Supervisor shall have at least five years of experience on projects involving contact grouting of jacking pipes and successfully completed at least three projects in the last five years performing contact grouting of jacking pipes similar to the type selected by the contractor for this project. Contact grouting shall be performed under the direct supervision of the Grouting Supervisor as required herein and the Grouting Supervisor shall be onsite during all contact grouting operations.

B. The Contractor shall provide quality control, testing, and inspection as required herein, and in accordance with accepted submittals.

C. Acceptance Criteria:

1. Contractor shall attain refusal at each and every grout port for the entire length of pipe.

2. Contract grout shall be acceptable if all 28-day samples meet the minimum 28-day strength requirements herein or if the average of all 28-day samples meet the minimum 28-day strength requirement herein and the weakest sample is within ten percent of the minimum 28-day strength requirement.

1.06 SUBMITTALS

A. Qualifications.

1. Contractor shall submit documentation demonstrating that the Contractor's Grouting Supervisor meets the minimum qualification requirements described in Article 1.05.A. herein. Documentation of qualifications shall be submitted a minimum of 30 days prior to the performance of any contact grouting.

2. Contractor shall provide the qualifications of the independent testing laboratory proposed to be utilized for testing of the contact grout as required herein.

B. Contact Grouting Plan.

1. The Contact Grouting Plan shall be submitted a minimum of 30 days prior to the performance of any contact grouting and shall include the following:

a. Descriptions and shop drawings describing and illustrating methods and equipment proposed for the performance of contact grouting. Include the methods of transportation and delivery of grout, sequence of the work, injection locations, and methods of verification of contact grouting. Include a layout figure showing the locations of the proposed equipment.

b. Mix design for contact grout including proportions of all constituents by weight or volume and their respective unit weights, and laboratory test results of the mix design to verify the strength and set time of the proposed mix design. Include manufacturer's product data, certificates of compliance, and safety data sheets for all constituents. Indicate the source of water proposed to be used. The submittal shall fulfill all of the testing requirements specified herein. Test results shall be made on the samples made using the same materials, including the same source of water and cement that will be used on the project.

c. Description of the equipment and methods proposed to mix contact grout, including batching and mixing equipment, methods of proportioning constituents, and associated instrumentation.

d. Description of the equipment and methods proposed for injection of contact grout, including pumping equipment, agitator, hoses, valve assembly, injection header, pressure gauges, bypass system., and methods of communication between mixing and injection operations. Include anticipated pumping distances, flow rates, and pressures. Include methods and description of instrumentation proposed for monitoring and control of placement of the contact grout and procedures to be used to check for voids and verify complete placement of contact grout. Include calibration certificates for any pressure gauges and meters used. Include drawings and description of grout ports, plugs, and shutoff valves for the ports, and the materials used to plug and/or permanently seal the grout ports following completion of contact grouting if not submitted with the jacking pipe.

e. Description of the handling and storage requirements for contact grout mix constituents, and waste disposal requirements for any spilled or excess contact grout. Include means and methods for cleaning of the internal surface of the jacking pipe.

f. Calculations of the maximum allowable injection pressures for contact grouting along the jacking pipe. Injection pressures shall be adequate to fill all voids and displace any remaining slurry, jacking pipe lubricants, air, and groundwater in the annulus between the outside face of the jacking pipe and the surrounding ground, while not causing damage to the jacking pipe, shafts, seals, or other construction, existing utilities, structures, or facilities, or heave of the ground surface.

g. Calculations demonstrating the theoretical volume of contact grout anticipated to be injected per foot of jacking pipe.

C. Reports and Records.

1. Submit within 24 hours at the end of each shift worked, Contractor's test reports and shift reports associated with contact grouting.

a. Test Reports. Provide test reports of the contact grout as required herein.

b. Shift Reports. The shift report shall include a daily log of the contact grouting operations and shall include the following information, regardless of actual progress made:

1). Names of personnel, their classification, and hours worked.

2). Daily grout injection records for each grout port:

a). Station, location, and orientation.

b). Grout mix design used and any alterations.

c). Batching time of each mix and time when injection began.

d). Duration of injection, quantity injected, injection pressure, and pumping rate. Include quantity wasted.

e). Any observed grout communication to other grout ports.

3). Total volume of grout injected and range of pressures applied for the day. Include a comparison to the calculated theoretical grout volume.

4). Duration and cause of any downtime or delays, regardless of cause.

5). Other information as requested by the Engineer.

D. Notifications:

1. The Contractor shall provide written notice to the Engineer 24 hours prior to the commencement of contact grouting operations.

2. The Contractor shall provide written notice to the Engineer 24 hours prior to any proposed addition, deletion, or change to the scheduling of shift work, or mix design.

3. The Contractor shall provide written notice to the Engineer 24 hours prior to performance of any gauge and meter tests.

2.00 PRODUCTS

2.01 MATERIALS

A. Contact Grout:

1. The contact grout shall be a mixture of cement and water with a maximum water to cement ratio of 2:1 by volume and a 28-day compressive strength of at least 500 psi. If sand is used, sand shall comply with ASTM C33/C33M and the water to cement to sand ratio by volume shall be between 1:1:0.5 to 1:1:1. The addition of sand may require the addition of fluidifier to the grout mix, as acceptable to the Engineer. Fluidifers shall be in conformance with ASTM C937. Water shall be from a potable water source.

2. Grout constituents shall be in compliance with NSF/ANSI Standard 60.

2.02 EQUIPMENT

A. Grouting Equipment: The grouting equipment shall at a minimum consist of a high-speed mixer, paddle type agitator, progressing helical cavity (Moyno) type grout pump, grouting header, and a water meter.

1. The grouting equipment shall include controls for proportioning, batching, and mixing of the grout sufficient to assure the design mix is achieved as submitted and accepted.
2. The grouting equipment shall have the ability to grout to a pressure of at least 1.0 psi per foot of depth above the grout injection port with the most ground cover and the pressure shall be controllable to within 0.5 psi. A pressure gauge shall be provided at the injection location with a range suitable for the anticipated grouting pressures with an accuracy of 0.1 psi or better to monitor the grouting pressures.
3. The grouting equipment shall have the ability to pump grout at a rate of at least 20 gallons per minute (gpm). A flow meter shall be provided at the injection location with a range suitable for the anticipated grout flow rates with an accuracy of 0.2 gpm or better to monitor the grout flow rates.
4. A separate valve and spigot shall be provided at or very near the grout injection location for obtaining grout samples for testing.

B. Packers and Shutoff Valves:

1. Packers shall be capable of sealing grout ports without leakage when grouting at the maximum injection pressure and after being removed after the grout has set. Packers shall be provided with shutoff valves.
2. Shutoff valves shall be supplied for grout ports in the vicinity of active grouting operations to observe grout communication at least 50 feet beyond the location of active grout injection.

3.00 EXECUTION

3.01 GENERAL

A. Contact grouting shall progress sequentially in a constant direction from one grout port to the next adjacent grout port in the sequence indicated in the accepted submittals. Contact grouting shall start from the grout port at the lowest elevation and then advance to the next lowest grout port in elevation. Grout ports shall not be skipped. Do not pump grout into more than one grout port at any time.

B. The contact grouting pressure shall be sufficient to fill all voids and displace any remaining slurry, jacking pipe lubricants, air, and groundwater in the annulus between the outside face of the jacking pipe and the surrounding ground. The maximum allowable injection pressure shall be maintained from the start of the injection through refusal for each grout port.

C. The maximum injection pressure at each grout injection port shall be limited to 0.5 psi per foot of depth above the grout injection port unless as otherwise calculated by the Contractor in the accepted submittal. The injection pressure shall be limited as to not cause damage to the jacking pipe, shafts, seals, existing utilities, structures, or other facilities, or cause heave of the ground surface. The Contractor is solely responsible for any damage caused by contact grouting operations and shall repair any damage caused at no additional cost to the Owner.

D. Contact grouting ports ahead of the grouting operation shall be cleaned and opened. Shutoff valves or other suitable devices shall be attached and placed in the fully open position for all opened ports within the maximum grout communication distance, as

required herein or otherwise determined by the Contractor and accepted by the Engineer. The opened ports shall also allow for escape of slurry, jacking pipe lubricants, air, and groundwater in the annulus as such are displaced by the contact grout.

E. When grout is found to flow from an adjacent grout port at a consistency equal to that being injected, plug such adjacent connections or install shutoff valves for bleed, until later use as a grout connection. Do not close any valved or open grout port until grout of the same consistency as that being injected is observed. After the grouting is completed and reaches refusal at each grout port, the shutoff valve shall be closed before the grout header is removed. The grout port shutoff valve shall remain closed until grout has set. Once the grout has set, the shutoff valve can be removed from the grout port and the grout port shall be filled, patched, and/or plugged in accordance with the jacking pipe manufacturer's recommendations and in accordance with the accepted submittal.

F. Operator of grout mixer and grout injection valves shall be in constant communication during all grout injection operations. Contractor shall monitor pressure gauges and flow meters at all times.

G. Grout shall be continuously recirculated after mixing and during grouting operations. Any grout not placed within 90 minutes of mixing shall be wasted and disposed of. Such grout shall be removed from the mixer, pump, and supply lines.

H. Promptly remove and dispose of any leakage or wastage of grout, or other objectionable materials. If such materials bond to the surface of the interior of the jacking pipe, remove by chipping, bush hammering, grinding, or other means acceptable to the jacking pipe manufacturer and the Engineer.

I. At the end of each shift, the surface of the interior of the jacking pipe shall be cleaned and the invert shall be maintained free of debris. Prior to cleaning or flushing grout delivery lines, disconnect injection valve from grout port to avoid pressure surges.

3.02 FIELD QUALITY CONTROL

A. Master Gauges and Meters:

1. Contractor shall perform testing of all field gauges and meters no less often than weekly using master gauges and meters or as otherwise required by the respective manufacturer's recommendations. Perform all tests in the presence of the Engineer.

2. Verify accuracy of master gauges and meters through the use of a testing laboratory no less often than every two months or as otherwise required in accordance with the respective manufacturer's recommendations.

B. Grout Testing:

1. For the contact grout mix design submittal, Contractor shall obtain and test nine samples for each proposed grout mix design and determine set time of the grout mix and corresponding compressive strength as well as the 7-day and 28-day compressive strength in accordance with ASTM C39/C39M.

2. During performance of contact grouting, Contractor shall prepare, obtain, cure, protect, and transport samples of contact grout in accordance with ASTM C31/C31M. The samples shall be obtained from a spigot and valve at or very near the point of placement to obtain a representative sample. Obtain at least one set of three samples for each

250 linear feet of jacking pipe, but not less than one set for each shift where contact grouting is performed. Contractor shall obtain and prepare samples in the presence of the Engineer. The 7-day and 28-day compressive strength of the samples shall be determined in accordance with ASTM C39/C39M.

END OF SECTION

33 30 00 MICROTUNNELING

1.00 GENERAL

1.01 SCOPE OF WORK

A. Contractor shall furnish all labor, equipment, and materials as required to construct microtunnels at the lines and grades as shown on the Drawings and to the tolerances and other requirements listed herein. The Contractor shall select, procure, furnish, install, and operate a microtunnel boring machine (MTBM) and ancillary equipment to install jacking pipe while minimizing the possibility of loss of ground, over-excavation, settlement, or heave of the ground surface, and prevent damage to existing utilities, structures, and other facilities.

B. All Work specified herein is the responsibility of the Contractor and is subject to the acceptance of the Engineer. Contractor shall perform all Work in accordance with all current applicable Federal, State, and local laws, regulations, ordinances, and codes. Contractor shall perform all Work in accordance with any permits required by agencies having jurisdiction. All work described herein shall be performed in conformance with the American Society of Civil Engineers ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, unless otherwise stated herein. In the event of conflict between such laws, regulations, ordinances, codes, guidelines, or the requirements listed herein, the Contractor shall comply with the more conservative or more stringent requirements. No part of this specification shall be construed as a relaxation of any such laws, regulations, ordinances, or codes.

1.02 RELATED SECTIONS

A. Section 33 05 01.07 “Reinforced Concrete Pipe.”

B. Section 33 13 54 “Geotechnical Instrumentation and Monitoring.”

C. Section 33 23 24 “Contact Grouting.”

D. Section 33 31 13.13 “Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.”

E. Section 33 73 15 “Shaft Excavation.”

F. Section 33 73 16 “Groundwater and Surface Water Control.”

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).

B. American Society of Civil Engineers (ASCE) - ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, 2015.

C. ASCE, Geotechnical Baseline Reports for Construction, Suggested Guidelines, 2007.

D. National Fire Protection Code (NFPA) - NFPA 70, National Electrical Code.

E. NSF International/American National Standards Institute (NSF/ANSI) – NSF/ANSI Standard 60: Drinking Water Treatment Chemicals - Health Effects.

F. Occupational Safety and Health Administration (OSHA) Safety and Health Regulations for Construction, 29 CFR Part 1926.

1.04 DEFINITIONS

A. Definitions are as stated in ASCE/CI Standard 36-15, Chapter 3 Definitions, unless modified or supplemented herein.

1.05 DESIGN CRITERIA

A. The MTBM shall have seals capable of withstanding all ground loads, groundwater and surface water loads up to elevation 21.0 feet MSL, and all other external loads or construction loads with appropriate factors of safety.

B. The microtunnel entry and exit seals and pipe brakes or clamping devices shall be capable of withstanding all ground loads, groundwater and surface water loads up to 21.0 feet MSL, and all other external loads or construction loads with appropriate factors of safety.

C. The MTBM and ancillary equipment selected by the Contractor shall be compatible with the ground conditions presented in the Geotechnical Data Report (GDR) and the baseline conditions presented in the Geotechnical Baseline Report (GBR).

1.06 QUALITY ASSURANCE AND CONTROL

A. Microtunnel Contractor: The Contractor performing microtunneling shall have successfully completed at least three microtunneling projects in last five years installing jacking pipe 60-inches or larger in diameter with drive lengths of 1,000 feet or greater using similar methods as specified herein and in similar ground conditions to that of this project.

B. Microtunnel Project Manager: The Contractor's Microtunnel Project Manager shall have at least ten years of experience in tunnel or trenchless construction industry as a project manager and successfully completed at least three microtunneling projects in the last ten years utilizing similar methods as specified herein and in similar ground conditions to that of this project.

C. Microtunnel Superintendent: The Contractor's Superintendent shall have at least five years of experience on projects involving microtunneling while serving as a superintendent and successfully completed at least three microtunneling projects in the last five years installing jacking pipe 60-inches or larger in diameter with drive lengths of 1,000 feet or greater using similar methods as specified herein and in similar ground conditions to that of this project. Microtunneling operations shall be performed under the direct supervision of the Microtunnel Superintendent and the Microtunnel Superintendent shall be on site during all microtunneling operations.

D. Microtunnel Operator: The Contractor's MTBM Operator shall have at least five years of experience as an operator of MTBMs and successfully completed at least three microtunneling projects in the last five years installing jacking pipe 60-inches or larger in diameter with drive lengths of 1,000 feet or greater using similar methods as specified herein and in similar ground conditions to that of this project. Operation of the MTBM shall only be performed Microtunnel Operator and the Microtunnel Operator shall be on site during all microtunneling operations.

E. The Contractor shall provide quality control, testing, and inspection as required herein, and in accordance with accepted submittals. The Contractor's engineer responsible for designs required herein shall visit the site to observe the work in progress as necessary to ensure the Work is conducted in accordance with the design and that the design assumptions are accurate based on field conditions.

F. Acceptance Criteria: The jacking pipe installation by pipe jacking associated with microtunneling shall be acceptable if the following tolerances to line and grade are met:

1. Horizontal Alignment: Maximum departure of 6 inches at any point along the theoretical microtunnel centerline.

2. Vertical Alignment: Maximum departure of 1 inch at any point along the theoretical microtunnel grade line.

3. Water shall be free draining between any two points along the invert of the jacking pipe. No reverse grades shall be allowed.

1.07 SUBMITTALS

A. Qualifications. Contractor shall submit documentation demonstrating that the Contractor and the Contractor's Project Manager, Superintendent, and MTBM Operator meet the minimum qualification requirements described in Article 1.04. herein. Documentation of Contractor's qualifications shall be submitted a minimum of 30 days prior to the mobilization of the MTBM to the site.

B. Microtunneling Work Plan. The Microtunneling Work Plan shall be a single comprehensive submittal and include the below documentation describing the means and methods of microtunneling operations and the proposed MTBM and ancillary equipment. The Microtunneling Work Plan shall be submitted a minimum of 30 days prior to the mobilization of the MTBM and ancillary equipment to the site.

1. Provide a detailed description of the proposed MTBM and ancillary equipment and procedures to be employed. Include manufacturer's literature, shop drawings, and operator manual for the MTBM and ancillary equipment describing in detail the type, size, and capabilities of the equipment to be used. Include details for the slurry separation plant, control cabin, generator, lighting, and ventilation systems.

2. Describe the procedures to minimize the loss of ground and prevent over-excavation, settlement, and heave while performing microtunnel excavation and provisions for protecting existing utilities, structures, and other facilities. Provide calculations that demonstrate the predicted maximum settlement will remain within the limits defined in Section 33 13 54 "Geotechnical Instrumentation and Monitoring."

3. Provide descriptions of previous projects where this MTBM and ancillary equipment has been successfully used including project names and contact information of respective owner, engineer, and contractor for these projects as well as dates and duration of construction, microtunnel drive length, diameter and type of pipe material installed, overall project cost, and geological and geotechnical conditions encountered.

4. Provide sample outputs of electronic reporting from MTBM and ancillary equipment and forms for manual reporting of construction activity.

5. Provide a layout figure of each area where microtunneling will be performed, including locations of shafts, geotechnical instrumentation, pipe storage, crane and other material handling equipment, jacking arrangement, control cabin, slurry separation plant, stockpiles of excavated materials, generator, and haul route.
6. Provide a schedule for the sequence of operations for microtunnel construction and duration for each of the activities, which shall include the items listed below at a minimum. Any action with an anticipated duration longer than one week shall be listed separately. Contractor shall indicate the proposed number of shifts, working days, and working hours for each activity. The initial schedule shall be provided with the Microtunnel Work Plan. The schedule associated with microtunnel construction shall be updated by the Contractor and submitted to Engineer on a bi-weekly basis upon commencement of microtunnel excavation. Contractor shall refer to the requirements of Section 01 33 05 “Construction Progress Schedule,” unless modified or supplemented herein.
    a. Procurement and delivery of MTBM and ancillary equipment
    b. Procurement and delivery of jacking pipe
    c. Installation of initial support systems and excavation of shafts
    d. Installation of entry and exit seals and thrust blocks
    e. Installation and setup of MTBM and ancillary equipment
    f. MTBM excavation and installation of jacking pipe
    g. Retrieval and removal of the MTBM
    h. Contact grouting of jacking pipe
    i. Testing of jacking pipe
    j. Backfill of shafts and removal of initial support systems
7. Provide a detailed description of the alignment control, surveying, and steering systems for the MTBM. Provide manufacturer’s literature and drawings showing setup and support provisions, and other details for the systems. Submit a description of surveying methods to set laser positions and a description of procedures to check laser and reset or realign laser during construction. Confirm that these systems can meet the required line and grade installation tolerances for the jacking pipe herein.
8. Submit name and resume of the Contractor’s Professional Land Surveyor licensed in the State of Texas who shall be responsible for setting survey control and equipment for monitoring of MTBM excavation and jacking pipe installation.
9. Provide capacity, location, number, and arrangement of main jacks. Provide details of thrust ring, jacking controls, and pressure gages. Provide details of the intermediate jacking stations, including manufacturer’s literature, product data sheets, and design drawings of the sleeve, jacks, and other components, if required. Include proposed spacing and maximum jacking force of the intermediate jacking stations.
10. Provide design and details for thrust blocks, entry and exit seals, and pipe brakes or clamping devices. Coordinate the design of thrust blocks, entry and exit seals, and pipe brakes or clamping devices with the design of the initial support systems for shaft

excavations in accordance with Section 33 73 15, “Shaft Excavation.” Design of thrust blocks, entry and exit seals, and pipe brakes or clamping devices shall be signed and sealed by a Professional Engineer licensed in the State of Texas retained by the Contractor with applicable experience with trenchless construction.

a. Submit calculations demonstrating that the thrust blocks can transfer the maximum anticipated forces developed by the main jacks to the ground or initial support system without excessive ground movements or damage to the initial support system of the shaft excavation.

b. Submit calculations demonstrating that the entry and exit seals can accommodate all ground, groundwater, and all other loads, including those exerted by the MTBM while providing a watertight seal against the MTBM as it is advanced through the entry and exit seals.

c. Submit calculations demonstrating the pipe brakes or clamping devices provide a sufficient resistant force against ground, groundwater, and all other loads acting on the MTBM.

11. Provide details of the slurry and pipe lubricants to be used during microtunneling, including manufacturer’s literature and safety data sheets. Include mix design, pumping pressures, and estimates of volumes to be injected.

12. Provide details of slurry handling, separation, transport, and disposal equipment and procedures. Include product data and details of the slurry additives, slurry separation plant, and the location of disposal sites for slurry and excavated materials separated from the slurry. Include details for monitoring of the volume of excavated materials collected versus the volume of slurry versus the advance rate of the MTBM to monitor the potential for over-excavation.

13. Submit written documentation from the accepted disposal sites indicating that they will accept the excavated materials and slurry and are in compliance with all applicable Federal, State, and local regulations for disposal of such materials.

14. Provide a safety plan for the microtunneling operations including provisions for ventilation and electrical system safeguards. Submit name of Contractor’s site safety representative responsible for implementing safety program.

15. Provide a general plan, procedures, and details for constructing recovery shafts and other methods to remove obstructions in the event that such are encountered during microtunneling.

C. Jacking Pipe: Provide submittals for fiberglass reinforced jacking pipe as required by Section 33 31 13.13 “Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe” or for reinforced concrete jacking pipe as required by Section 33 05 01.07 “Reinforced Concrete Pipe,” in addition to the following submittals for the jacking pipe:

1. Details, shop drawings, and proposed locations of lubrication and grouting ports.

2. Demonstrate that the Contractor’s selected jacking pipe material is compatible with the ground conditions presented in the GDR and baseline conditions presented in the GBR, and that the jacking pipe is compatible with the Contractor’s selected MTBM and ancillary equipment.

3. Calculations, signed and sealed by a Professional Engineer licensed in the State of Texas retained by the Contractor with applicable experience in trenchless construction, demonstrating:
    a. Contractor's proposed jacking pipe material, including joint type and wall thickness, can accommodate, with appropriate factors of safety, all ground and groundwater loads, handling and transportation loads, proposed lubrication and grouting pressures, and proposed jacking forces imposed on the jacking pipe by the Contractor's chosen MTBM and ancillary equipment, including intermediate jacking stations, if required.
    b. Maximum allowable jacking force to be on the jacking pipe, based on the chosen factor of safety and the anticipated maximum joint deflection angle. This value of allowable jacking force should not be exceeded during performance of microtunneling operations.
    c. Maximum jacking force expected to be imposed on the jacking pipe to complete each drive. Include a graphical plot of distance versus jacking force for each drive. Provide separate estimates for skin friction forces and face pressure.

D. Contingency Plans. Provide Contingency Plans, including, but not limited to the following situations:
    1. Slurry is accidentally released to the surface from the MTBM
    2. Slurry is accidentally released to the surface from a break or leak in the piping between the MTBM and the slurry separation plant.
    3. Inability of steering or control system of MTBM to meet line and grade tolerances for the jacking pipe.
    4. Inability of slurry separation plant to effectively separate excavated materials from the slurry.
    5. Laser or survey system distorted by heat, humidity, and/or a physical disturbance.
    6. Jacking forces reach or exceed design capacity of jacking pipe, jacking frame, and/or thrust block.
    7. Ground or groundwater inflows into microtunnel, shaft, or entry or exit seals, increase significantly and possibly transport fines into tunnel and/or shaft.
    8. Loss of ground, over-excavation, settlement, or heave is observed.
    9. Pipe break or pipe clamping device does not sufficiently resist the ground and groundwater loads exerted on the MTBM.
    10. Jacking pipe has been damaged or has been found to be out of compliance with specifications, either before, during, or after installation.
    11. Source of power to MTBM and ancillary equipment is interrupted.
    12. Mechanical breakdown of MTBM.
    13. Pipe string cannot be advanced forward due to excessive skin friction or lack of adequate lubrication.
    14. MTBM cannot be advanced forward due to an obstruction.

15. MTBM rolls beyond the manufacturer's recommendations during excavation.
16. Failure of sensors or data collection system onboard MTBM.
17. Significant storm event, hurricane, or flooding at the site.
18. Encountering obstructions that prevent advance of the MTBM.

E. Reports and Records.

1. Submit within 24 hours of the end of each shift worked, regardless of progress made: Contractor's survey notes, records, and shift reports associated with microtunneling, as well as a digital records.

    a. Shift Report. The shift report shall include a daily log of the microtunneling and pipe jacking operations at intervals of not more than one pipe length and shall include the following information, regardless of the amount of progress made each day:

        1). Names of personnel, their classification, and hours worked.

        2). Position of the MTBM in relation to design line and grade.

        3). Jacking forces exerted on the pipe at each jacking station and total force exerted.

        4). Date, start, and finish of each pipe jacking operation.

        5). Amount of lubricant used, its viscosity, and pumping pressure.

        6). Volume of excavated materials removed from the site.

        7). Distance tunneled and number of pipes installed.

        8). Construction observations, such as settlement.

        9). Duration and cause of any downtime or delays, regardless of cause.

        10). Other information requested by the Engineer.

    b. Digital Records. The digital records shall include a log of data collected by the MTBM data logger. The digital records shall include all previous records for the current drive, display units of measure for all recorded parameters, and shall be in Microsoft Excel format. The digital records shall include the following information recorded at intervals no greater than fifteen seconds during microtunneling and pipe jacking operations:

        1). Position and deviation of the MTBM in relation to design line and grade.

        2). Jacking forces at each location where force is applied and total jacking force.

        3). Rate of advance.

        4). Inclination, yaw, pitch, roll.

        5). Cutterhead torque, rate of rotation, and direction of rotation.

        6). Slurry flow rates in both the feed and return lines.

        7). Face or slurry chamber pressure.

        8). Position of steering jacks.

9). Amount of lubricant used, its viscosity, and pumping pressure.

10). Distance tunneled and number of pipes installed.

11). Other pertinent information recorded by the MTBM or as requested by the Engineer.

2. The Contractor shall provide the Engineer, in a form acceptable to the Engineer, an as-built record drawing of each microtunnel drive showing in detail the installed vertical and horizontal alignment and deviation from design line and grade of the microtunnel from data collected at a minimum at every joint of jacking pipe for each drive.

1.08 SAFETY

A. The Contractor's methods of construction shall be such as to ensure the safety of the Work, project participants, the public, third parties, and adjacent property, whether public or private. The Contractor shall be solely and completely responsible for maintaining safe work conditions at the site at all times.

B. The Contractor's safety officer shall administer an accident prevention program and shall prepare a code of safe practices and an emergency plan. Contractor shall hold safety meetings and provide safety instruction for new employees.

C. Contractor shall provide acceptable instrumentation for testing and monitoring of the quality of the air in manned work areas. Contractor shall obtain air samples under working conditions at prescribed intervals in accordance applicable requirements. Submit the results of the air quality tests to the engineer each week during the performance of the work with Contractor's daily reports.

2.00 PRODUCTS

2.01 EQUIPMENT

A. Microtunnel Boring Machine (MTBM). The MTBM shall be a closed and pressurized face machine designed and built or rebuilt for the ground conditions on this project by a recognized MTBM manufacturer with a minimum of 5 years of experience in the design and manufacture of MTBMs of this type. The manufacturer must still be in the business of designing and manufacturing MTBMs. All of the various components and systems, which make up the MTBM shall be new or reconditioned so that the machine is ready to operate upon installation at the site. The MTBM and all ancillary equipment shall be able, with excess capacity, to handle all ground loads, groundwater loads, construction loads, and all other loads through the ground conditions presented in the GDR and the baseline conditions presented in the GBR, and shall satisfy the following requirements:

1. The machine shall be capable of fully supporting the face during both excavation and shutdown periods, and shall have the capability of exerting a controllable, measurable, continuous, stabilizing pressure at the face as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface.

2. The MTBM shall be a slurry type machine with pumps or air chambers to provide a pressurized mixture of excavated ground and slurry that balances the encountered ground and groundwater pressures. The system shall be capable of adjusting as required

to balance the pressures encountered at the tunnel face to an accuracy of one foot of equivalent hydrostatic pressure.

3. The machine shall utilize a slurry transportation system that is synchronized with advance rate of the MTBM to avoid over excavation. The system shall be capable of bypassing the cutterhead and changing direction of the flow to flush or clear debris that may be encountered.

4. The machine shall be provided with an enclosed chamber for containing the slurry under pressure. A pressure gauge should be provided so that operator can monitor the slurry chamber pressure. The system shall be capable of making the adjustments required to counterbalance the earth pressures as needed to prevent loss of ground, settlement, or heave. If pressure monitoring capability is lost for any reason, tunnel excavation shall stop until pressure monitoring has been restored.

5. The machine shall be remotely operated, laser guided, and monitored continuously by an MTBM operator in a control cabin on the surface. A display showing the position of the MTBM in relation to design line-and-grade shall be provided at the operator's console to allow the operator to monitor the location of the heading of the machine, face pressure, jacking forces (including all intermediate jacking stations, as applicable), cutterhead torque, cutterhead rotation rate and direction, rate of advance, line and grade deviation, yaw, pitch, roll, inclination, laser position, slurry face pressure, slurry flow rates in both supply and return lines, and other pertinent information. The machine shall have a data logger that records all the above parameters continuously at intervals no greater than every fifteen seconds. The Contractor shall at all times provide and maintain instrumentation and sensors that will accurately provide to the Engineer all required reports and records. This data from the data logger shall be submitted to the Engineer on a daily basis as required herein. The control cabin shall be accessible for observation by the Engineer at all times.

6. The machine shall have a laser guidance system with a light sensitive or electronic target appropriate for the drive lengths required and capable of constructing the microtunnel and installing jacking pipe to the line and grade tolerances provided herein.

7. The machine shall have an articulated shield that is steerable in both vertical and horizontal directions to maintain line and grade within the specified tolerances herein. The cutterhead shall have a reversible drive system so that it can rotate in either direction to minimize rotation or roll of the MTBM and jacking pipe string during excavation. Antiroll fins or grippers may also be utilized, but shall not be the primary method of controlling rotation or roll.

8. Slurry used to support the face of the excavation and to transport excavated muck may need to be produced using bentonite and/or polymer additives. Suitable ground conditioning additives shall be used during excavation as necessary to minimize the clogging potential during excavation. For clayey soils, Contractor shall consider utilizing non-aqueous materials as clayey soils are subject to swelling when wetted. It is the Contractor's responsibility to tailor the slurry to the actual ground conditions. Slurry constituents shall be in compliance with NSF/ANSI Standard 60.

9. Provide a slurry separation plant that is appropriate for the type of ground being excavated, and compatible with the anticipated excavation rate, effective in removing the excavated materials from the slurry for reuse of the slurry, and of appropriate size for the available area for construction. Use settlement tanks, shakers, vibrating screens, hydro-cyclones, and/or centrifuges as required for effective removal of solids from the slurry. Monitor the composition of the slurry to maintain the slurry density and viscosity limits as indicated in the accepted submittals.
10. The machine shall be equipped for continuous gas monitoring and shall have a master shut-off switch.
11. The tail of machine shall have gaskets and seals to prevent material and groundwater from running into the tunnel at the contact between the tail skin and the jacking pipe to the pressures required herein.

2.02 PIPE JACKING SYSTEM

A. The main jacks shall be mounted in a jacking frame and located in the jacking shaft. The MTBM shall be moved forward by the jacking system advancing a successive string of jacking pipes toward a receiving shaft. The force applied by the jacking system shall be uniformly distributed at the end of the string of jacking pipes by the use of thrust rings and packing in accordance with the pipe manufacturer's recommendations.

B. A pipe lubrication system shall be used to lower the friction developed on the surface of the jacking pipe during jacking operation to minimize jacking forces. A lubricant, typically bentonite and/or polymers, shall be injected at the rear of the MTBM or through lubrication ports. Lubricants shall be in compliance with NSF/ANSI Standard 60 and subject to acceptance by the Engineer.

C. The pipe lubrication system pressure shall be continuously monitored, recorded, and controlled to prevent pipe buckling and/or ground heave.

D. Thrust block shall be perpendicular to the proposed pipe alignment. The thrust block shall be capable of resisting the maximum jacking pressure that can be developed by the main jacking system.

E. The jacking system shall have a rated capacity of least 25 percent greater than the required maximum allowable jacking force calculated by the Contractor. At no time shall the jacking system be operated to exceed the maximum allowable jacking force of the jacking pipe calculated by the Contractor, including all safety factors and accounting for any joint deflection.

F. Intermediate jacking stations shall be utilized when jacking forces reach 80% or greater of the maximum allowable jacking force based on the capacity of the jacking pipe, thrust block, or jacking equipment, whichever is less. When intermediate jacking stations are utilized, the maximum jacking force shall not exceed the maximum allowable jacking force of the pipe.

G. Contractor shall maintain at least one intermediate jacking station on site that is available for use if the jacking forces, as calculated by the Contractor as required herein, are to exceed 75% of the maximum allowable jacking force.

2.03 MATERIALS

A. Jacking pipe material shall be fiberglass reinforced jacking pipe as specified in Section 33 31 13.13 “Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe” or reinforced concrete jacking pipe as specified in Section 33 05 39 “Reinforced Concrete Pipe.” For every joint of pipe or every 10 feet, whichever is smaller, at least three grout/lubrication injection ports shall be provided and spaced equilaterally around the pipe. Ports shall be at least two inches in diameter and threaded. Ports shall be installed in the wall of the jacking pipe by the pipe manufacturer. Ports shall not be installed in the field by the Contractor by drilling through the wall of the pipe or other methods.

3.00 EXECUTION

3.01 GENERAL

A. The excavation and installation of the associated initial support systems of the launch and retrieval shafts for the microtunnel drives are to be completed prior to commencement of MTBM excavation. Shaft Excavations shall be performed in accordance with Section 33 73 15 “Shaft Excavation.” Contractor shall provide all necessary coordination between different subcontractors performing shaft excavation and microtunneling, if applicable.

B. Contractor shall provide entry and exit seals to prevent inflow of ground and groundwater and loss of slurry and lubricants at the shaft interface as the MTBM and jacking pipe is advanced through the wall of the shaft. The seals shall be designed by the Contractor to resist the ground, groundwater, and all other loads while maintaining a watertight seal. A backup or emergency seal system, such as an inflatable seal, shall be used in conjunction with the primary seal. Grout injection ports at a maximum of 30 degree radial spacing shall be incorporated into each seal location.

C. Contractor shall perform all microtunnel excavation and installation of jacking pipe as shown on the Drawings and as specified herein. The excavated diameter of the microtunnel shall be a minimum size determined by the Contractor to allow for installation of jacking pipe by pipe jacking with an allowance for injection of slurry or lubricants into the annulus between the outside of the jacking pipe and the surrounding ground.

D. The MTBM shall be operated to minimize loss of ground and prevent over-excavation, settlement, or heave of the ground during microtunneling. Restrict the excavation of the materials to only those materials that are physically displaced by the shield itself to prevent over-excavation, loss of ground, and settlement, or possible damage to existing utilities, structures, or other facilities. Control the advance rate and monitor the face pressures and volume of material excavated and adjust the advance rate, as required. No high-pressure water jetting shall be allowed at the face of the excavation in non-cohesive soils.

E. Pressure applied at the tunnel face during microtunneling shall be maintained at all times and shall be slightly higher than the combination of the active earth pressure and hydrostatic pressure. Contractor shall monitor piezometers and river gauges to obtain groundwater level measurements to assist in the determination of hydrostatic pressure.

F. All work shall be performed so as not to disturb existing utilities, structures, or other facilities. Any damage shall be immediately repaired to the satisfaction of the property or

utility owner, residents, and/or agency having jurisdiction, and the Engineer, at no additional cost to the Owner. If any survey benchmarks points are disturbed, such shall be reestablished by a professional land surveyor licensed in the State of Texas by the Contractor at no additional cost to the Owner.

G. Contractor shall provide means of communication between the MTBM operator in the control cabin, crane operator, and personnel working at the top and bottom of the shaft. A closed-circuit television system shall be installed by the Contractor for the MTBM operator to view all of the operations at the bottom of the shaft from the control cabin.

H. No gasoline powered equipment shall be permitted in jacking and receiving pits. Diesel, electric, hydraulic, and compressed air powered equipment is acceptable, subject to applicable Federal, State and local regulations.

I. Conduct all operations such that trucks and other construction equipment and vehicles do not create a dust nuisance along roads and adjacent properties. Promptly clean up, remove, and properly dispose of excavated materials or slurry spillage.

J. The Contractor shall obtain and pay for a suitable source of electric power for all Work associated with microtunneling, this includes, but is not limited to furnishing a generator or obtaining and paying for any permits and installation fees from the local electric power utility and performing associated electrical work. The Contractor shall be responsible for furnishing and installing all electrical equipment and wiring required for microtunneling.

K. The Contractor shall obtain and pay for a suitable water source for all Work associated with microtunneling, this includes, but is not limited to obtaining and paying for any permits and hydrant meters from the local water utility.

L. The Contractor shall allow the Engineer's and Owner's representative access to and inside the MTBM control cabin and shafts for observation of the microtunneling operations at all times.

M. During microtunneling, Contractor shall perform geotechnical instrumentation and monitoring as required by Section 33 13 54 "Geotechnical Instrumentation and Monitoring."

N. The Contractor shall construct recovery shafts, in accordance with accepted submittals, if obstructions are encountered which stop or prevent the microtunneling machine from advancing. The recovery shafts shall be constructed in accordance with Section "33 73 15 Shaft Excavation." Contractor shall obtain necessary approvals from property owners and agencies having jurisdiction for the locations of such recovery shafts, and proceed with the construction of recovery shafts as required to remove obstructions and minimize delays in the work.

3.02 PIPE INSTALLATION

A. Pipe installation shall be performed in accordance with applicable provisions of Section 33 31 13.13 "Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe" or Section 33 05 39 "Reinforced Concrete Pipe." Pipe installation shall also be performed in accordance with the pipe manufacturer's recommendations and accepted submittals.

B. Provide a suitable jacking frame and thrust block to perform pipe jacking. Provide intermediate jacking stations if required to complete the required drives as required herein. A thrust block is required to transfer jacking loads to the ground adjacent to the jacking

shaft. The thrust block shall be properly designed and constructed and shall be perpendicular to the proposed jacking pipe alignment. The thrust block shall be designed to support the maximum obtainable jacking pressure developed by the main jacks.

C. Special care shall be taken when setting the jacking frame and pipe guide rails prior to starting the work in the jacking shaft to ensure accuracy of the line and grade of the jacking pipe and stability of the pipe guide rails. Survey the location and orientation of the guide rails to ensure they are on the proper line and grade and verify that they are properly supported.

D. Jacking pipe sections shall be handled and transported from the storage area to the jacking shaft properly in accordance with the jacking pipe manufacturer's recommendations to avoid damage. Set the jacking pipe sections properly, which shall be braced and supported by guide rails. Join the two sections of jacking pipe together following the below joint connection procedures or as otherwise recommended by the jacking pipe manufacturer or as indicated in accepted submittals.

   1. Clean both ends of each jacking pipe section and the joint components.
   2. Apply joint lubricant to the bell interior surface and gaskets. Use only lubricants approved by the jacking pipe manufacturer.
   3. Use suitable equipment and end protection to push the jacking pipes together.
   4. Do not exceed forces recommended by the jacking pipe manufacturer for jointing or pushing jacking pipe.

E. The axial forces from the thrust jacks shall be distributed to the pipe uniformly through a properly designed thrust ring and cushion materials, as recommended by the jacking pipe manufacturer, to prevent damage to the ends of the pipe. Jacking forces shall be applied uniformly to the pipe wall. The jacking system shall be capable of continuously monitoring the jacking pressure and advance rate of the jacking pipe to adequately support the surrounding ground at all times.

F. Pipes shall be jacked into position following the design line and grade of the pipeline without damaging the pipe. In the event a section of the pipe is damaged during the jacking operation, the pipe shall be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, subject to the acceptance by the Engineer.

G. Provide a lubrication system and inject lubricants through injection ports in the jacking pipe as necessary, to minimize friction. Lubricants shall be injected continuously as the pipe is advanced. The volume injected shall not be less than that required to fill the annulus outside the jacking pipe.

H. Pipe joints shall be leak free when installed.

I. Contractor shall provide a positive restraint or other necessary measures, including implementing a pipe brake or clamping device to prevent the pipe string from being pushed backwards into the shaft during the addition of pipe segments, when the jacking frame is not in operation, or during other shutdown periods. Contractor shall constantly apply necessary forces to maintain the stability of the face of the excavation.

J. As soon as each microtunnel drive has been completed and the pipe is in its final position, the interface of the jacking pipe and the walls of the shaft shall be grouted as necessary to prevent further ground and groundwater inflow into the shaft and contact grouting of the jacking pipe shall be performed in accordance with Section 33 23 24 – Contact Grouting.

3.03 EXCAVATION AND DISPOSAL

A. Use slurry transportation system for all excavation performed by microtunneling.

B. Properly handle, transport, and dispose of all excavated materials away from the construction sites in accordance with all applicable Federal, State, and local regulations. Slurry generated from microtunneling operations shall be pumped into tanks and properly transported and disposed of at acceptable facilities in accordance with applicable Federal, State and local regulations for disposal of such materials.

3.04 CONTROL OF LINE AND GRADE

A. The Contractor shall verify the accuracy of benchmarks and survey control points on the Drawings prior to commencement of construction and report any errors or discrepancies to the Engineer immediately. Contractor shall establish additional control points as necessary that are sufficiently far away from the Work to be performed so as to not be affected by the potential for ground movement associated with microtunneling.

B. When satisfied that all benchmarks are correct, use such benchmarks to furnish and maintain all reference lines and grades for the performance of microtunneling. Surveying shall be performed by a Professional Land Surveyor licensed in the State of Texas. Submit to the Engineer copies of the field notes used to establish all the lines and grades and allow the Engineer to review laser setup prior to beginning microtunneling operations. The Contractor shall be fully responsible for the accuracy of the Work and the correction of any defective work, as required.

C. Laser shall be mounted independently from the thrust block and jacking frame in order to maintain the alignment of the laser. Contractor shall stop microtunneling operations and reset laser if laser alignment shifts or is moved off of design alignment and grade for any reason. Laser shall only be reset by qualified surveying personnel in accordance with accepted procedures.

D. Contractor shall monitor line and grade continuously during microtunneling operations. Record deviation from design line and grade at least once per foot and submit records to the Engineer as requested. Control line and grade of the pipe to within the specified tolerances herein.

E. If the pipe installation exceeds the specified tolerances herein, Contractor shall notify the Engineer immediately. Contractor shall return to the theoretical microtunnel line and/or grade at a rate of not more than one inch per 25 feet of drive length. If the tunnel deviates sufficiently off plan line and/or grade to require a redesign of the microtunnel, including the addition or modification of manholes or other structures, in the opinion of the Engineer, the Contractor shall have the system redesigned at no additional cost to the Owner. All corrective work shall be performed as acceptable to the Engineer and at no additional cost to the Owner.

3.05 CONSTRUCTION AREA APPEARANCE

A. Throughout the duration of the project, the Contractor shall keep all pavement and access roads, within and leading to the project limits, free from all debris produced from construction. The Contractor shall keep the project and surrounding areas neat and free from dust and debris. The Owner or Engineer may require supplementary measures as necessary.

B. Upon completion of the Work, the Contractor shall remove all equipment, signs, and unused or excess materials provided for the Work and shall restore the project area to a neat and clean condition as required by the Contract Documents.

3.06 FIELD TESTS AND INSPECTIONS

A. Contractor shall perform field testing of the jacking pipe as required in Section 01 40 00 "Quality Management," Section 33 31 13.13 "Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe," and Section 33 05 39 "Reinforced Concrete Pipe," as applicable. The Engineer shall witness all field testing performed by the Contractor.

B. Perform field tests and provide labor, equipment, and incidentals required for the required testing. Contractor shall be able to produce evidence, when required, that each item of work has been constructed properly in accordance with the Contract Documents.

3.07 EMERGENCY MEASURES

A. Whenever there is a condition that is likely to endanger the stability of the excavation or existing utilities, structures, or other facilities, the Contractor shall operate with a full crew for 24 hours a day, including weekends and holidays, without intermission until those conditions no longer jeopardize the stability of the Work. Emergency operations that cannot be attributed to a differing site condition shall be performed by the Contractor at no additional cost to the Owner.

END OF SECTION

33 31 13.13 FIBERGLASS (GLASS-FIBER-REINFORCED THERMOSETTING-RESIN) PIPE

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to furnish and install centrifugally cast or filament wound fiberglass reinforced polymer mortar pipe, fittings, joints, and connections to new or existing pipe or headwalls, manholes, etc., to the lines and grades and at the diameters indicated on the Drawings. For pipe to be installed by microtunneling/pipe jacking methods, such pipe shall be furnished and installed in accordance with the requirements of Section 33 30 00 "Microtunneling." For pipe to be installed by open cut methods, trenching, backfilling, and embedment for such pipe shall be performed in accordance with the requirements of Section 31 23 33.19 "Trenching and Backfill [Plant Construction]."

B. The Work to be performed in this Section includes design calculations, detailing, and fabrication of pipe. Pipe design and associated calculations shall be performed by a Professional Engineer licensed in the State of Texas who is employed or retained by the Contractor. The design of the pipe shall include the selection of external loads, installation loads, and other loads as determined by the Contractor.

1.02 QUALITY ASSURANCE

A. Experience:

1. Pipe must be the product of one manufacturer with not less than five (5) years of successful experience manufacturing pipe of the type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, and coating) must be performed at one location unless otherwise acceptable to the Engineer.

2. Furnish an affidavit that the pipe, specials, fittings, and appurtenances furnished comply with all provisions of this Section and applicable ASTM and AWWA standards.

B. Owner Testing and Inspection: Pipe may be subject to inspection during manufacture by an independent testing laboratory selected and retained by the Owner or the Engineer. Representatives of the independent testing laboratory and the Engineer shall have access to the Work whenever it is in preparation or progress, and the pipe manufacturer must provide proper facilities for access and for inspection. The pipe manufacturer must notify the Owner in writing a minimum of two (2) weeks prior to pipe fabrication so that the Owner may advise the manufacturer as to the Owner's decision regarding tests to be performed by the independent testing laboratory. Material, fabricated parts, and pipe found to be defective or not conforming to the requirements of this Section will be subject to rejection at any time prior to Owner's final acceptance of the Project.

C. Factory Testing: At a minimum, the following tests must be conducted at the factory, with test results furnished to the Owner and Engineer:

1. Load bearing tests: Provide test results for the first joint manufactured of each size and class, and at least one joint per hundred joints thereafter.

2. Material tests: Provide material test results per the applicable ASTM and AWWA standards.

3. Pipes shall be manufactured and tested in accordance with ASTM D3262.
4. Coupling joints shall meet the requirements of ASTM D4161.
5. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall be 72 psi (SN 72).
6. The extrapolated 50-year strain corrosion value shall not be less than as determined in accordance with ASTM D3681 and ASTM D3262.

D. Manufacturer's Technician for Pipe Installation: Pipe manufacturer must furnish the services of a factory trained, qualified, field experienced technician during installation. The technician must assist and advise the Contractor in his pipe installation operations and must instruct construction personnel in proper joint assembly and joint inspection procedures. The technician is not required to be on-site full time. However, the technician must be on-site during the first two (2) 8-hour days of pipe installation and thereafter three (3) additional 8-hour days as requested by the Engineer, Owner, or Contractor.

E. Acceptable Manufacturers: Hobas Pipe USA or Thompson Pipe Group FRP.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Submittals for "Jacking Pipe" as required by Section 33 30 00 "Microtunneling."
2. Manufacturer's product data sheets, drawings, specifications, and other data, showing complete details of the fabrication and construction of each size and type of pipe and fittings, together with complete data covering all materials proposed for use, including the following:
    a. Pipe stiffness.
    b. Name of manufacturer.
    c. Nominal pipe diameter.
    d. Cell classification.
    e. Laying lengths.
    f. Joint and gasket details.
    g. Jointing methods and tolerances.
    h. Minimum radii for horizontal deflection.
    i. Details of reinforcement.
    j. Details of lubrication and grouting ports.
    k. Details of fittings and specials.
3. Pre-Construction submittal data and specifications shall include, but shall not be limited to, the following for each size and type of pipe:
    a. Manufacturer and manufacturer's qualifications.

b. Manufacturing Details. Description and specification of the manufacturer and methods of manufacture including reinforcing, casting, covering, and storage.

c. Material Properties. Submit data in support of the materials used meet or exceed the specified properties for all materials used including, reinforcing, gaskets, and protective lining, if applicable.

d. Shop drawings showing pipe details including:

1). Pipe size, wall thickness, length, and dimensions.

2). Reinforcing method, stiffness, and cover.

3). Joint details with type and configuration sizes, dimensions, and gasket grooves.

4). Grout port arrangement and details.

5). Fabrication tolerances for all pipe dimensions.

6). Shop drawings shall be prepared, signed, and sealed by a Professional Engineer licensed in the State of Texas employed or retained by the Contractor.

e. Detailed structural calculations for the pipe confirming the pipe can adequately resist anticipated installation loads, including handling and jacking loads, in-situ and service loads, and all other associated design loads, provides the required factor of safety against buckling, and meets the required maximum allowable long-term deflection.

1). Calculations shall show loading and other design criteria, design standards, formulas, assumptions, loads, methods of analysis intermediate steps, and results of stresses and displacements.

2). If computer calculations are performed, example calculations shall be furnished to show the procedures used by the software.

3). Calculations shall be submitted showing that pipe and joints can adequately resist anticipated installation loads, including handling and jacking loads, in-situ and service loads, and all other associated design loads with required factors of safety.

4). Calculations shall be prepared, signed, and sealed by a Professional Engineer licensed in the State of Texas employed or retained by the Contractor.

f. Pipeline layout and profile drawings showing the location, stationing, and invert elevations of pipe sections, fittings, and closure pieces, if applicable.

g. Handling and storage details and shop drawings of methods of transportation from the manufacturing location to the site and methods and equipment used to handle and store.

4. Prior to shipment of the pipe, the pipe manufacturer shall submit the following:

a. A Certificate of Adequacy of Design stating that the pipe to be furnished complies with ASTM D2412, ASTM D3262, ASTM D3567, ASTM D4161, AWWA M45, and these specifications.

b. Certified Test Reports from the manufacturer's testing facility or an acceptable testing laboratory for the factory testing required herein. Test reports shall include certification of compliance with specified standards.

1). Certified Test Reports from the manufacturer's testing facility or an acceptable testing laboratory for materials tests (ASTM D2412 and ASTM D3681).

2). Certified Test Reports from the manufacturer's testing facility or an acceptable testing laboratory for load bearing tests.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 "Document Management."

B. Section 01 40 00 "Quality Management."

C. Section 31 23 33.19 "Trenching and Backfill [Plant Construction]."

D. Section 33 23 24 "Contact Grouting."

E. Section 33 30 00 "Microtunneling."

1.05 STANDARDS

A. The applicable provisions of the following standards must apply as if written here in their entirety. Piping and fittings must be in full compliance with the applicable standards and specifications. Pipe may be rejected for failure to comply with any requirement of this Section. Whenever a conflict exists between the standards and the requirements herein or between separate standards, the most stringent requirement shall govern.

1. American Society of Civil Engineers (ASCE) Standards:

ASCE/CI 36-15	Standard Design and Construction Guidelines for Microtunneling

2. ASTM International (ASTM) Standards:

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D3567	Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
ASTM D3681	Standard Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition
ASTM D3754	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D3839	Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

3. American Water Works Association (AWWA) Standards:

AWWA C950	Fiberglass Pressure Pipe
AWWA M45	Fiberglass Pipe Design

1.06 DESIGN CRITERIA

A. Pipe, joints, and gaskets shall be designed and furnished by the Contractor in accordance with the requirements of the standards listed herein except as modified or supplemented herein.

B. Pipe Inside Diameter: Refer to the Drawings.

C. Installation Tolerances: Refer to Section 33 30 00 – Microtunneling.

D. Design Earth Cover Height Above the Top of the Pipe: Refer to the Drawings.

E. In Situ Soil Characteristics and Water Table Elevation: Refer to the Geotechnical Baseline Report and Geotechnical Data Report.

F. Live Load: Equal to HS-20.

G. Surcharge Load: As determined by the Contractor during construction.

H. Groundwater Load: Refer to the Geotechnical Baseline Report and Geotechnical Data Report.

I. Intermittent Hydrostatic Pressure or Other Loads: Assume Maximum Water Surface Elevation of 21.00 feet with the pipe empty or pipe full of water.

J. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall be 72 psi (SN 72).

K. Refer to additional design criteria provided in Section 33 30 00 – Microtunneling.

1.07 DELIVERY, HANDLING, STORAGE, AND MARKING

A. An inspection of the pipe will be made by the Engineer after delivery. Contractor shall make periodic inspections of stored pipe materials to assure that materials are maintained under specified conditions and free from damage or deterioration. Pipe with visible defects will be rejected and replaced at no additional cost to the Owner. Visible defects include cracks of any type, honeycombs, delamination, or any other defects indicative of poor workmanship. Any pipe rejected shall not be returned under any circumstances to the Project.

B. Pipe damaged in shipment shall not be unloaded at the Site.

C. Deliver, handle, and store pipe in accordance with the manufacturer's recommendations.

D. Pipe Marking: The following information shall be clearly marked on each joint of pipe and each fitting must have plainly marked on the inside of the pipe at two locations by the pipe manufacturer:

1. The class and stiffness for which it is designated,

2. AWWA and/or ASTM standard designation,

3. The date of manufacture and identification of plant,

4. The name or trademark of the manufacturer,

5. Diameter of the pipe,
6. Identification number corresponding to the laying schedule, and
7. The top centerlines must be marked on all specials.

2.00 PRODUCTS

2.01 MATERIALS

A. Resin Systems: The manufacturer must use only polyester resin systems with a proven history of performance in this application. The historical data must have been acquired from a composite material of similar construction and composition as the proposed product.

B. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components must be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

C. Silica Sand: Sand must be minimum 98 percent silica with a maximum moisture content of 0.2 percent.

D. Additives: When used, resin additives such as curing agents, pigments, dyes, fillers, thixotropic agents, etc. may not detrimentally affect the performance of the product.

E. Elastomeric Gaskets: Gaskets must be supplied by qualified gasket manufacturers and be suitable for the service intended and comply with ASTM F477.

2.02 MANUFACTURED PRODUCTS

A. Manufacture pipes to result in a dense, non-porous, corrosion resistant, consistent composite structure. The interior surface of the pipes exposed to flow must be manufactured using a resin with a 50 percent elongation (minimum) when tested in accordance with ASTM D638, or a glass reinforced liner system. The interior surface must provide crack resistance and abrasion resistance. The exterior surface of the pipes must be comprised of a sand and/or resin layer which provides UV protection to the exterior. Pipes must be Type 1, Liner 1 or 2, Grade 1 or 3 per ASTM D3262.

B. Unless otherwise specified, the pipe shall be field connected with flush fiberglass sleeve couplings or flush bell-spigot joints, that utilize elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain water tightness. The joints must meet the performance requirements of ASTM D4161. Joints at tie-ins may utilize a fiberglass, gasket-sealed coupling.

C. Flanges, elbows, reducers, tees, wyes, laterals, and other fittings must be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays, designed to perform without failure in all possible operating conditions.

D. Pipe must be manufactured and tested in accordance with the applicable standards. Coupling joints must meet the requirements of ASTM D4161. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall be 72 psi.

E. Tee-Based Manhole fittings must be made with fiberglass pipe and must include a minimum 30-inch diameter manway.

F. Reference Section 33 39 13 “Manholes, Frames and Covers” for riser material.

2.03 DIMENSIONS

A. Dimensions called for on the Drawings are inside diameters and are minimums. The actual outside diameter shall be in accordance with applicable standards and shall be in accordance with manufacturer's literature.

B. Pipe shall be supplied in nominal lengths of 10 to 40 feet. Other lengths may be supplied upon approval of the Engineer. Actual laying length must be a nominal plus one (+1) inch to minus four (-4) inches or as acceptable to the Engineer. At least 90 percent of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

C. Pipe ends must be square to the pipe axis with a minimum tolerance of one-eighth (1/8) inch.

3.00 EXECUTION

3.01 PIPE INSTALLATION, HANDLING, AND JOINTING

A. Install 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, ASTM D3839, and AWWA M45.

B. For pipe to be installed by microtunneling/pipe jacking methods, pipe installation shall also be in accordance with Section 33 30 00 "Microtunneling."

C. For pipe to be installed by open cut methods, trenching, backfilling, and embedment for pipe shall also be in accordance with the requirements of Section 31 23 33.19 "Trenching and Backfill [Plant Construction]."

D. Pipe shall be installed to the lines and grades indicated.

E. Each joint of pipe must be inspected immediately prior to being lowered into the excavation. If repair of damaged areas and holidays is permitted by Engineer, repair those areas per the pipe manufacturer's recommendations before the pipe is lowered into the excavation.

F. Install pipe as specified. Pipe installation methods will be subject to the acceptance of the Engineer. Pipe must be lowered into the excavation using textile slings. Chains or cables shall not be used for handling the pipe.

G. Do not damage the gaskets or the ends of the pipe joints. Prior to connecting the joints, inspect and verify that the pipe ends and gaskets are thoroughly clean with no foreign materials adhering to them. Coat the pipe ends or groove slopes of the pipe with a lubricating material in accordance with the manufacturer's recommendations. Petroleum lubricants shall not be permitted. Assemble the pipe with sufficient force necessary to make a tight seal on the gasket. Extreme caution shall be taken by the Contractor so as not to damage the pipe. Do not exceed the forces recommended by the manufacturer for joining the pipe. For pipe to be installed by microtunneling/pipe jacking methods, do not exceed the jacking forces recommended by the manufacturer and as required by Section 33 30 00 "Microtunneling".

H. Check joints with a feeler gauge. If any irregularity in the position of the gasket is detected at any point on the entire circumference of the pipe, remove the pipe and examine the gasket for cuts. If the gasket is undamaged, it may be used again, but the gasket and the joint must be re-lubricated. After the pipe section is joined, check the line and grade.

I. The maximum deflection of any joint may not exceed 75 percent of the manufacturer's maximum recommended joint deflection.

J. Protection: Protect pipe from damage before, during, and after installation until backfill or grouting is complete. Protect the Work and materials of other trades. In event of damage, make all necessary repairs and replacements as recommended by the pipe manufacturer at no additional cost to the Owner.

3.02 GROUTING

A. For pipe installed by microtunneling/pipe jacking methods, contact grouting shall be performed after each drive is completed in accordance with Section 33 23 24 "Contact Grouting."

3.03 FIELD QUALITY CONTROL

A. Conduct pipe testing as outlined below.

B. Infiltration/Exfiltration Test:

1. Perform infiltration/exfiltration tests after installation. The Contractor shall perform an infiltration test when pipes are installed below the ground water level.

2. For exfiltration tests, the length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2 feet or 2 feet above the current ground water level, whichever is higher.

3. Plug the pipe with pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.

4. Continue the test for 1 hour. For exfiltration tests, make provisions for measuring the amount of water required to maintain the water at a constant level during this period. For infiltration tests, determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and locations are subject to the Engineer's acceptance.

5. Determine the maximum allowable infiltration or exfiltration rate by the following formula:

$$L = \frac{C \times D \times S}{126{,}720}$$

Where L is the allowable infiltration or exfiltration rate in gallons per hour; S is the length of pipe tested in feet; D is the nominal diameter of the pipe in inches; C is the infiltration or exfiltration rate. Use a value of 50 for C for pipe installed outside of the 25-year floodplain, and use a value of 10 for C for pipe installed within 25-year floodplain.

6. Pipe with visible infiltration or exfiltration, or pipe that exceeds the maximum allowable infiltration or exfiltration rate herein is considered defective and must be corrected by performing repairs as recommended by the pipe manufacturer.

C. Air Test for Individual Joints:

1. Pipe 36 inches in diameter and larger shall be tested at individual joints as recommended by the manufacturer. Each joint shall be tested unless otherwise acceptable to the Engineer.

2. Unless otherwise recommended by the manufacturer, the shortest allowable time for the test pressure to drop from 3.5 pounds per square inch (gauge pressure) to 2.5 pounds per square inch (gauge pressure) is 10 seconds for all pipe sizes.

3. Pipe joints that exceed the maximum allowable pressure drop over a specific period of time as recommended by the manufacturer or herein are considered defective and must be corrected by performing repairs as recommended by the pipe manufacturer.

D. Deflection Testing for Pipe:

1. Perform deflection tests on flexible and semi-rigid pipe in accordance TCEQ requirements.

a. The maximum allowable deflection of pipe measured as the reduction in vertical inside diameter is 75% of the manufacturer's recommendation.

a. Conduct test after the final backfill has been in place a minimum of 30 days.

b. Thoroughly clear the lines before testing.

2. Perform test by pulling a properly sized mandrel through the line up to 48-inches in diameter.

3. Repair pipe with deflections in excess of the maximum allowable deflection as recommended by the pipe manufacturer.

E. Engineer may require additional performance tests of the joints.

F. Contractor shall not enclose or cover any Work until inspected and required testing has been completed and accepted by the Engineer.

END OF SECTION

33 39 13 MANHOLES, FRAMES AND COVERS

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to construct manholes and cleanouts complete with covers, fittings, and other appurtenances, in accordance with the details and/or called out in the Drawings. Polymer concrete manholes may be used in lieu of precast reinforced concrete manholes at no additional cost to the Owner and as acceptable to the Engineer.

1.02 QUALITY ASSURANCE

A. Polymer Concrete Manholes:

1. Certification from manufacturer that polymer concrete manhole design meets or exceeds the load and strength requirements of ASTM C478 and ASTM C857, reinforced in accordance with ASTM C478 or ACI 440.1R.
2. Proof of independent chemical resistance testing conducted in accordance with ASTM C267.
3. Manufacturer must provide references of 10 previous polymer concrete projects including scope in the last 5 years performed with both the owner and contractor for reference and review.

1.03 SUBMITTALS

A. Submittals must be in accordance with Section 01 33 00 “Document Management” and must include:

1. Shop Drawings:
    a. Drawings and data covering manhole sections. These drawings must include manhole designation matching the plans, invert elevations, and diameters for each manhole.
    b. Concrete batch mix for cast-in-place sections must be submitted as a Shop Drawing.
2. Product Data:
    a. Manhole cover and ring.
    b. Include other products as specified herein.
3. Polymer Concrete Manholes:
    a. Certification from the manufacturer that polymer concrete manhole design meets or exceeds the load and strength requirements of ASTM C478 and ASTM C857, reinforced in accordance with ASTM C478 or ACI 440-1R.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 “Document Management.”

B. Section 01 40 00 “Quality Management.”

C. Section 03 30 00 “Cast-in-Place Concrete.”

D. Section 31 23 10 “Structural Excavation and Backfill.”

E. Section 33 73 15 “Shaft Excavation.”

1.05 STANDARDS

A. Applicable provisions of the following standards apply as if written here in their entirety:

1. American Concrete Institute (ACI) Standards:

ACI 440-1R	Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars

2. American National Standards Institute (ANSI) Standards:

ANSI A21.10	American Water Works Association (AWWA) Standard for Ductile-Iron and Gray-Iron Fittings

3. ASTM International (ASTM) Standards:

ASTM A48	Standard Specification for Gray Iron Castings
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C267	Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C497	Standard Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C857	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3575	Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM D3753	Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes and Wetwells
ASTM D4819	Standard Specification for Flexible Cellular Materials Made from Polyolefin Plastics

ASTM D4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D6783	Standard Specification for Polymer Concrete Pipe
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts

1.06 DELIVERY AND STORAGE

A. Do not deliver precast concrete sections to the Site until representative concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

B. Inspect manhole sections upon delivery and reject any cracked or otherwise visibly defective units.

2.00 PRODUCTS

2.01 MATERIALS

A. Concrete and Mortar:

1. Concrete, mortar, and non-shrink grout for all cast-in-place manholes and/or bases must be as specified in Section 03 30 00 “Cast-In-Place Concrete.”

2. The minimum compressive strength for concrete is 3,000 psi.

2.02 MANUFACTURED PRODUCTS

A. Precast Concrete Manholes:

1. Above the manhole base, manholes must be constructed with precast concrete rubber gasket sections in accordance with ASTM C478 pipe as shown on the Drawings using materials as specified below.

2. Material must be a non-shrink, non-metallic cement-based grout.

3. Rubber Gaskets: Neoprene or other synthetic, 40 plus or minus 5 hardness when measured by ASTM D2240, Type A durometer.

4. Precast Cone: Precast cone must be concentric.

5. Manhole steps must not be furnished for manholes.

6. All pipe sections must be machine made by a process that must provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which must assure a dense concrete in the finished product, except that reducer cones may be wet-cast.

7. Aggregates for the concrete must comply with the requirements of ASTM C33, with the additional requirement that the aggregate must have a minimum of 50 percent of calcium carbonate equivalent.
8. Minimum wall thicknesses for the manhole risers must be as listed under Wall "B" in the ASTM C76 "Class Tables."
9. Approved Manufacturers:
    a. Forterra Pipe and Products.
    b. Approved equal.

B. Polymer Concrete Manholes:
1. Riser Sections:
    a. Provide base riser section with monolithic floors, unless shown otherwise in the Drawings.
    b. Provide riser sections joined with bell and spigot/ship-lap design seamed with butyl mastic (ASTM C990) and rubber gaskets (ASTM C443) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure. Joints shall meet the testing requirements without the use of an external joint wrap.
    c. Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter indicated in the Drawings. Use various lengths of polymer concrete manhole sections in combination to provide the correct height with the fewest joints. Lifting inserts shall not fully penetrate the wall.
2. Resin: The manufacturer must use only polyester or vinyl ester resin systems designed for use with this particular application. Resin additives such as curing agents, pigments, dyes, fillers and thixotropic agents, when used, must not be detrimental to the manhole. Minimum resin content shall not be less than 7 percent by weight.
3. Aggregate: All aggregate, sand, and quartz powder must meet the requirement of ASTM C33, where applicable. Limestone aggregates shall not be used.
4. Polymer concrete must have a minimum compressive strength of 9,000 psi when measured in accordance with ASTM C497.
5. Elastomeric Gaskets: Gaskets must be suitable for the service intended and must meet the requirements of ASTM C443. Assembled joints shall meet the testing requirements of ASTM C443 without the use of an external joint wrap. Pipe to manhole connections shall be accomplished with connectors meeting ASTM C923 for both materials and performance requirements. Proof of connector testing can be requested from connector manufacturer.
6. Marking and Identification: Each manhole must be marked with the manufacturer's name and production date.
7. Invert Channel: Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe to manhole connections. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab for buoyancy concerns can be addressed with cementitious concrete material.

8. Manholes must be reinforced per ASTM C478 or ACI 440-1R and designed to withstand all live loads and dead loads as described in the Drawings. Manhole wall thickness must be designed to resist hydrostatic pressures with a minimum safety factor of 2.0 for full depth conditions from grade to invert.
9. Materials needed for grouting and patching must be a polyester mortar compound provided by the manufacturer or as approved by the manufacturer.
10. Approved Manufacturers:
    a. Armorock Polymer Concrete.
    b. U.S. Composite Pipe, Inc. (a division of Thompson Pipe Group).
    c. Approved equal.

C. Non-Metallic Manhole Rings and Covers:

1. All rings and covers must be made from high strength nonmetallic fiber reinforced polymer/composite materials. The material must be a resin thermoset matrix that can be reinforced with continuous filament engineered fabrics, fiber rovings, short fiber filaments, or equivalent nonmetallic reinforcing structure(s). Sealing gaskets must be bonded to the frame continuously at the interface with the cover to reduce wear, shock, noise, malodors and infiltration.
2. Rings and covers intended for traffic service must be capable of withstanding AASHTO M306: Proof Testing (includes items such as frames, covers, etc.).
3. Fabricate rings and covers to conform to shapes, dimensions, and with wording or logos shown in the Drawings.
4. Molding Process:
    a. Before the moldings are removed from the molding operation, they must be thoroughly de-flashed and cleaned at the parting lines, holes, notches and all exposed edges.
    b. If using a lock or latch, these must be independent of the method used to open the cover to ensure the cover can be opened in the event of lock or latch failure.
    c. Covers and frames must be compression molded under high pressures (>0.5 tons/sq. inch of x-y surface area) and high temperatures (>200 deg F).
    d. Metal reinforcements or metal hinges molded within the composite will not be permitted. Small non-stress bearing pieces of metal may be encapsulated or attached.
5. All rings and covers must be molded and assembled in the United States in accordance with the requirements of AASHTO M306.
6. Covers must be provided with a positive sealing mechanism utilizing 316 stainless steel hardware with nuts molded in or attached at pre-molded designated points of the frame and must be Teflon coated. Other equivalent locking mechanisms must be approved by the Engineer.
7. Composite covers must be detectable by metal detectors.

8. Composite covers must be furnished with two concealed pick holes molded with 316 stainless steel inserts. An additional 316 stainless steel lifting clip must be molded into the top of the cover to facilitate removal and replacement.
9. Composite covers must have provisions for 316 stainless steel threaded inserts molded into the bottom surface to accommodate monitoring and remote transmission sensors and antenna utilized by the utility. Antenna placed on the bottom side must have the capability to transmit through the cover without the need to drill and install antenna on the upper surface.
10. Markings: Covers and frames must have the following molded into the substrate of the cover:
    a. Name (or abbreviation) of molder.
    b. Country of origin.
    c. Molding date.
    d. Indication that material is non-metallic.
11. Approved Manufacturers:
    a. Composite Access Products, L.P.
    b. Approved equal.

D. Manhole Grade Adjustment Rings:
1. Concrete Manhole Grade Rings:
    a. Grade adjustment rings must be pre-cast, reinforced concrete in conformance to ASTM C478.
    b. Mortar concrete grade rings using 1 part Portland cement and 2 parts sand and sufficient potable water to produce a working mixture.
2. HDPE and EPP Manhole Grade Rings:
    a. Grade adjustment rings must be made of high-density polyethylene (HDPE) meeting ASTM D4976 or expanded polypropylene meeting ASTM D3575 and ASTM D4819.
    b. Provide adhesive/sealant between each ring per the manufacturer's requirements.
    c. Approved Manufacturers:
        1). Ladtech, Inc.
        2). PRO-RING by Cretex Specialty Products.
        3). Approved equal.

3.00 EXECUTION

3.01 INSTALLATION

A. Manhole Sizing: Manhole diameters are to be as indicated in the Drawings or as indicated below. If there is a conflict between the Drawings and these requirements, the larger manhole diameter will be required.

1. Pipe Diameters 18 Inches and Smaller: Provide 48-inch inside diameter manholes.
2. Pipe Diameters 24 to 27 Inches: Provide 60-inch inside diameter manholes.
3. Pipe Diameters 30 Inches and Larger: Provide 72-inch inside diameter manholes.

B. Foundation Support: Manholes must be founded on stable subgrade. Excavate and prepare the subgrade in accordance with Section 31 23 10 "Structural Excavation and Backfill." Precast base units must be founded on a minimum 6-inch-thick layer of compacted course aggregate bedding. A pipe section with a prefabricated tee manhole and half the length of the adjoining pipe sections on each side must be founded on a minimum 6-inch layer of Class A concrete. The cradle is to extend to the trench walls and to the spring line of the pipe.

C. Manhole Base:

1. Tee Manhole Base: The applicable details as indicated in the Drawings apply. Form and place the base of the manholes under and around the pipe to form a flat platform above the top of the pipe to receive the precast circular manhole sections. After the manhole has been completed, entry to the pipe area must be made through a manway covered with a blind flange that is fabricated to the top of the pipe. Any debris resulting from this operation must be completely removed from the interior of the pipe.
2. Give the concrete portion of all inverts within the manholes a smooth steel trowel finish.
3. The first section of pipe extending out a minimum of 24 inches from each side of the manhole base must be supported by lean concrete as part of the manhole base.

D. Precast Manholes: The tops of the manholes will be set to proper elevation by using a predetermined length of the bottom section of the manhole riser and using standard lengths for the other sections of the riser pipe.

E. Monolithic Manholes: Pour monolithic concrete manholes on the Site using specifically designed, re-usable plastic or metal forms. Pour manholes using 3000-psi concrete to provide a formed wall thickness of at least 8 inches. Monolithic manholes must be substantially water-tight when completed. Bases or footing for these manholes must be as described above.

F. Non-Metallic Manhole Rings and Covers: Install composite frames and covers according to approved Shop Drawings, instructions in related specifications and details, and written installation instructions from manufacturer. Set units accurately at required locations to proper alignment and elevation. Keep units plumb, level, true, and free of trash. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.

G. All adjustments to the manhole lid and cover must be completed prior to final grading.

3.02 GROUTING

A. Use the mortar for grouting within 40 minutes after mixing. Discard mortar which has begun to take an initial set. Do not mix mortar with additional cement or new mortar.

3.03 BACKFILL

A. Backfilling of manholes shall be performed in accordance with the manhole manufacturer's recommendations and Section 31 23 10 "Structural Excavation and Backfill". For manholes located within shaft excavations, backfilling shall also be performed in accordance with applicable requirements of Section 33 73 15 "Shaft Excavation."

3.04 FIELD QUALITY CONTROL

A. Manhole Testing:

1. Test manholes for leakage separately and independently of the pipe by hydrostatic exfiltration testing, vacuum testing or other approved methods acceptable to the Engineer. Test manholes after installation with all connections in place. Plug lift holes with an approved non-shrink grout prior to testing.

2. Vacuum Test: Temporarily plug any lines entering the manhole with the plugs braced to prevent them from being drawn into the manhole. Install plugs in the lines beyond drop-connections, gas sealing connections, etc. Place the test head inside the frame at the top of the manhole and inflate in accordance with the manufacturer's recommendations. Draw a vacuum of 10 inches of mercury, then turn off the vacuum pump. Read the level of vacuum after the required test time with the valve closed. The manhole will pass the test if the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury). The required test time for 48-, 60-, and 72-inch manholes with depths up to 30 feet is 2 minutes. Test times for manholes of greater size and depths will be determined by the Engineer.

3. Manhole Repairs: Manholes will be accepted in accordance with the criteria above. Repair any manhole which fails the initial test with non-shrink grout or other suitable material as determined for the material from which the manhole is constructed. Retest the manhole as described above until a successful test is achieved. Remove all temporary plugs and grout after a successful test.

END OF SECTION

33 49 00 STORM DRAINAGE STRUCTURES

1.00 GENERAL

1.01 WORK INCLUDED

A. This item shall govern for the construction of manholes, inlets, and other drainage structures and appurtenances such as headwall and velocity dissipators, complete in place or to the stage detailed on the plans and the materials used therein, including excavation, installation, connections, backfilling, placement of the concrete and when required, the furnishing and installation of frames, grates, rings, covers, safety end treatments and any concrete curb and gutter indicated on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Drawings and data covering structures and appurtenances (manholes, inlets, headwalls, frames, grates, energy dissipators, etc.), construction methods and sequence (precast, cast-in-place), and materials (bolts, nuts, plates, angles, etc.).
2. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix.
3. Proposed proportioning of materials for the mortar mix.
4. Analysis and thickness calculations for temporary steel covers.

1.03 QUALITY ASSURANCE

A. The products shall meet the requirements of Section 01 40 00 “Quality Management.”, Section 03 11 00 “Concrete Forming”, Section 03 21 00 “Reinforcing Steel”, and Section 03 30 00 “Cast-In-Place Concrete.”

1.04 STANDARDS

A. The applicable provisions of the standards listed in Section 03 11 00 “Concrete Forming”, Section 03 21 00 “Reinforcing Steel”, Section 03 30 00 “Cast-In-Place Concrete”, and Section 33 42 16.13 “Precast Concrete Culverts”, and the following standards shall apply as if written here in their entirety:

1. American Society of Testing and Materials (ASTM) Standards:

ASTM A27/ A27M-95(2000)	Standard Specification for Steel Casings, Carbon, for General Application
ASTM A48	Specification for Gray Iron Castings
ASTM A47M-99	Standard Specification for Ferritic Malleable Iron Castings
ASTM A536-99e1	Standard Specifications for Ductile Iron Castings
ASTM C478	Specification for Precast Reinforced Concrete Manhole Sections
ASTM D2240	Test Method for Rubber Property – Durometer Hardness

ASTM A21.10	American National Standard for Gray Iron and Ductile Iron Fittings, 3 through 48 Inches for Water and other Liquids
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C33	Concrete Aggregates
ASTM C923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.05 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle all structures according to manufacturer's written rigging instructions.

D. Inspect precast concrete sections upon delivery and reject any cracked or otherwise visibly defective units.

1.06 JOB CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than 2 days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Owner's written permission.

2.00 PRODUCTS

2.01 MATERIALS

A. Portland Cement Concrete:

1. Portland cement concrete shall conform to Section 03 30 00 "Cast-In-Place Concrete", with the following classes:

a. Cast-in-Place Concrete: Class A.

b. Precast Concrete: Class C.

B. Mortar: Mortar shall be composed of 1 part Portland cement and 2 parts clean, sharp mortar sand suitably graded for the purpose by conforming in other respects to the provisions of Section 03 30 00 "Cast-In-Place Concrete" for fine aggregate. Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight (mass) of the total dry mix.

C. Reinforcement and Steel: Reinforcing Steel shall conform to Section 03 21 00 "Reinforcing Steel".

D. Safety End Treatment for Structures:

1. The safety end treatment for structures shall conform to TxDOT Specification Item No. 467, "Safety End Treatment".

2. Bolts and Nuts. All bolts, nuts and associated hardware shall meet the specifications of ASTM A 307.

3. Plates and Angles. All plates and similar angles and brackets shall meet the specifications of ASTM A 36.

4. Pipe Runners. Pipe Runners shall conform to the requirements of ASTM A53, Grade B.

5. Galvanizing. All hardware including nuts, bolts and plates listed above shall be galvanized conforming to ASTM A 123 or A 153.

E. Miscellaneous Items: Cast iron for supports, steps and inlet units shall conform to the shape and dimensions indicated on the Drawings. The casting shall be clean and perfect, free from sand or blowholes or other defects. Cast iron castings shall meet the requirements of ASTM A48, Class 30. Steel for temporary covers when used with stage construction shall be adequate for the loads imposed.

2.02 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings shall conform to Section 33 05 01.07 “Low Head Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe”.

2.03 MANHOLES

A. Precast Concrete Manholes: Above the manhole base, manholes shall be constructed with precast concrete rubber gasket sections in accordance with ASTM C478 pipe as detailed on the drawings using the following materials.

1. Non-Shrinking Grout: Material shall be a non-shrink cement-base grout. “Five-Star-Grout” as manufactured by U.S. Grout Corporation or “Supreme” grout as manufactured by Hanson Pipe and Products or approved equal.

2. Rubber Gaskets: Neoprene or other synthetic, 40 plus or minus 5 hardness when measured by ASTM D2240, Type A durometer.

3. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.

4. Precast Cone: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

5. Grade Adjustment Risers shall be pre-cast, reinforced concrete in conformance to ASTM C478.

6. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.

7. Manhole Frames and Covers: Ferrous; 32-inch ID by 7- to 9-inch riser with 4-inch minimum width flange and 34-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to “STORM SEWER.”

a. Material: ASTM A536, Grade 60-40-18 ductile or ASTM A48, Class 35 gray iron, unless otherwise indicated.

2.04 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C478 , precast, reinforced concrete, of depth indicated, with provision for sealant joints.

B. Cast-in-Place Concrete, Catch Basins: Construct of reinforced concrete; designed according to ASTM C890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.

   1. Bottom, Walls, and Top: Reinforced concrete.

   2. Channels and Benches: Concrete.

C. Frames and Grates:

   1. ASTM A536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

      a. Size: 24 by 24 inches minimum, unless otherwise indicated.

      b. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.05 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy-duty frames and grates according to utility standards.

3.00 EXECUTION

A. All concrete work shall be performed in accordance with Sections 03 11 00 “Concrete Forming”, Section 03 21 00 “Reinforcing Steel”, and Section 03 30 00 “Cast-In-Place Concrete.” Forms will be required for all cast-in-place concrete walls, except where the nature of the surrounding materials is such that it can be trimmed to a smooth vertical face (the outside form for concrete bases). Where cast-in-place concrete is used in wall construction of storm sewers, the Steps shall be cast into the wall the concrete is placed.

B. Construct manholes, inlets, headwall and velocity dissipators for precast concrete storm drain conduits as soon as practicable after conduits into or through the structure locations are completed. All conduits shall be cut neatly at the inside or outside face of the walls of the structures and pointed up with mortar.

C. Bases for cast in place inlets may be placed prior to or at the Contractor's option after the sewer is constructed.

D. Bases for box sewers shall be cast as an integral part of the sewer. The manholes may be constructed prior to backfilling or if the Contractor so elects, the manhole opening may be covered temporarily with a steel plate to facilitate the compaction of backfill for the sewer as a whole. Thereafter, required excavation for the inlet shall be made and the inlet constructed and backfilled.

E. The inverts passing out or through an inlet shall be shaped and grouted across the floor of the inlet as indicated on the Drawings. This shaping may be accomplished by adding shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

F. All miscellaneous structures shall be completed in accordance with the details indicated on the Drawings. Backfilling to original ground elevation shall be in accordance with the provisions of the appropriate items and as directed by the Engineer or designated representative.

G. Energy dissipators and headwalls shall be constructed in accordance with details shown in the drawings.

END OF SECTION

APPENDIX A

A1.00 MEASUREMENT AND PAYMENT

A1.01 MEASUREMENT

A. All miscellaneous structures and safety end treatments satisfactorily completed as indicated on the Drawings will be measured as completed units per each.

B. Concrete removal, excavation and backfill, riprap, pipe, headwalls, wing walls, collars and apron slabs will not be measured under this item but will be included in the unit price bid for the item of construction in which this item is used.

C. Frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated will not be measured and paid for but shall be included in the unit price bid of one of the pay items identified in the contract bid form.

A1.02 PAYMENT

A. Inlets - Payment for Inlets of the type indicated in place in accordance with these specifications and measured as prescribed above will be made at the unit bid price for each Inlet, of the type specified.

B. Energy Dissipators and Headwalls - Payment for special complete structures will be made at the unit price bid per each.

C. Safety End Treatment - Payment for Safety End Treatment, complete in place, will be made at the unit bid price for each unit of the type indicated on the Drawings.

D. Payment will be made under one of the following:

1.	Energy Dissipators	EA
2.	Headwalls, Type ___, ___ inch Dia. Pipe	EA
3.	Safety End treatment, Type ___, Size ___	EA
4.	Inlet (Type, Size)	EA
5.	Standard Manhole (Size)	EA
6.	Box Manhole (Size)	EA
7.	Junction Box (Size)	EA

END OF APPENDIX A

33 73 15 SHAFT EXCAVATION

1.00 GENERAL

1.01 SCOPE OF WORK

A. The Work includes shaft excavation and designing, furnishing, installing, maintaining, and removing initial support systems associated with shaft excavation. The initial support systems shall consist of watertight methods of support, including secant piles, slurry walls, or steel sheet piling.

B. All Work specified herein is the responsibility of the Contractor and is subject to the acceptance of the Engineer and the Owner. Contractor shall perform all Work described herein in accordance with all current applicable regulations and codes of Federal, State, and local agencies having jurisdiction. In the event of conflict between separate regulations or the requirements herein, the Contractor shall comply with the more stringent requirement. No part of this specification shall be construed as a relaxation of any applicable current Federal, State, or local regulations or codes.

C. Contractor shall furnish all labor, equipment, and materials required to support and excavate the shafts that are required to perform tunneling and other work as shown on the Drawings and as required herein. The Contractor's methods of excavation shall be compatible with the requirements as shown on the Drawings and as required herein. If the Contractor's selected type of initial support system fails to provide satisfactory performance, the Contractor shall provide another type of initial support system at no additional cost to the Owner.

D. The Contractor shall be solely responsible for the design of the initial support system. The design of the initial support system, including calculations, plans, specifications, and overall submittal for the initial support system shall be signed and sealed by a Professional Engineer licensed in the State of Texas with prior experience of design of initial support systems for similar applications in similar ground conditions.

E. The requirements presented herein shall be considered the minimum requirements and such requirements do not alleviate or diminish the sole responsibility of the Contractor for the design, installation, and maintenance of the initial support system and for the safety of workers.

1.02 RELATED WORK

A. Section 31 23 10 "Structural Excavation and Backfill."

B. Section 33 13 54 "Geotechnical Instrumentation and Monitoring."

C. Section 33 30 00 "Microtunneling."

D. Section 33 73 16 "Groundwater and Surface Water Control."

1.03 QUALITY ASSURANCE AND CONTROL

A. Shaft excavation operations shall be performed under the direct supervision of a qualified superintendent who is assisted by experienced foremen. Both the superintendent and

foremen shall have at least five years of experience with similar projects utilizing similar methods to those required herein, and in similar ground conditions.

1.04 DESIGN CRITERIA

A. The watertight initial support systems for shaft excavations shall be designed by the Contractor in accordance with general engineering design practice and all applicable requirements of the Occupational Safety and Health Agency (OSHA). The Contractor's design shall also be performed in accordance with applicable codes, requirements, specifications, and standards, including those of the following organizations:

   1. American Concrete Institute (ACI)
   2. American Institute of Steel Construction (AISC)
   3. International Building Code (IBC)

B. The Contractor shall design watertight initial support systems, including temporary watertight working slabs at the bottom of such initial support systems, to withstand all ground and groundwater pressures, bottom heave, equipment loads, traffic and construction loads, temporary stockpiles, stored materials, and other surcharge loads to allow for the safe performance of the Work to be performed inside and adjacent to shafts without excessive ground movement or settlement of the ground, and to prevent damage to adjacent existing structures, utilities, and other facilities. The embedment depth of the initial support system below the bottom of the excavation shall be sufficient to minimize lateral and vertical movement of the surrounding ground.

C. The design of the initial support system shall consider sequence of construction, including installation the initial support system, performing shaft excavation, performing tunnel excavation, installation of structures within the initial support system, placement of concrete lining within the initial support system, and backfilling and removal of the initial support system, as applicable.

D. The initial support systems shall be compatible with the Contractor's chosen means and methods to construct tunnels between shafts in accordance with Section 33 30 00 – Microtunneling. The design of the initial support system shall include provisions for watertight entry and exit of tunneling equipment into and out of the shaft and thrust blocks at the opposite wall of the shaft, as required for the tunneling and pipe jacking equipment.

E. The Contractor's design of the initial support systems shall be compatible with the ground conditions presented in the GDR and the baseline conditions presented in the GBR.

F. Contractor shall design each member or support element of the initial support system to support the maximum loads that are possible to occur during construction with appropriate safety factors.

G. Contractor shall utilize walers, struts, and beams for bracing and lateral support as required for initial support systems. Provide struts with intermediate vertical and horizontal supports as required to prevent buckling.

H. Watertight working slabs shall be provided at the bottom of each shaft excavation and shall be designed to provide stable support for construction operations.

I. The initial support system shall limit movement or settlement of ground adjacent to the shaft excavation within the allowable limits in accordance with Section 33 13 54 "Geotechnical Instrumentation and Monitoring."

J. The initial support system shall be watertight to prevent lowering of the groundwater level outside of the shaft excavation and allow for the control of groundwater in accordance with Section 33 73 16 "Groundwater and Surface Water Control."

K. Shafts shall be protected from flooding. The design of the initial support system for each shaft shall include a water retaining liner that extends at least two feet above the 100-year flood elevation. The water retaining liner can be preassembled and stored at the site for immediate installation in lieu of being installed during construction activity.

L. Review of the Contractor's submittals for the initial support systems by the Engineer does not relieve the Contractor and the engineer retained by the Contractor, of their responsibility to provide and maintain adequate initial support systems for shaft excavations meeting the requirements herein.

1.05 SUBMITTALS

A. At least 30 days prior to the start of shaft construction, the Contractor shall submit the following to the Engineer for review:

1. Contractor performing shaft excavation shall have experience with shaft excavation and shall provide evidence of at least five years of experience of performing shaft excavations utilizing methods similar to those required herein, and in similar ground conditions. Contractor performing shaft excavation shall submit the resume of the Contractor's superintendent and foremen demonstrating relevant experience as required by Article 1.03.A. herein.

2. Shaft Excavation Work Plan shall include, but not be limited to, descriptions of the proposed site facilities, proposed equipment to be utilized for installation, maintenance, and removal of initial support systems, and shaft excavation and backfilling, proposed methods for installation, maintenance, and removal of the associated initial support systems, proposed methods for shaft excavation, spoil handling, stockpiling, disposing, and backfilling, and proposed equipment for ventilation and lighting. The Shaft Excavation Work Plan shall be coordinated with the Groundwater Control Plan as required by Section 33 73 16 "Groundwater and Surface Water Control."

3. The design of each initial support system shall include plans and specifications for the installation, maintenance, and removal (to the extent required) of the initial support system, design criteria, calculations, assumptions, and loadings. The design shall include a table of minimum setback distances from the edge of the initial support system for vehicles, equipment, and materials to be used during construction. The design of each initial support system shall be signed and sealed by a Professional Engineer licensed in the State of Texas.

4. The Professional Engineer retained by the Contractor responsible for designing initial support systems shall submit a resume demonstrating at least five years of experience in the design of initial support systems for shaft excavations utilizing methods similar to those required herein, and in similar ground conditions.

5. Proposed grout mix design and procedures for filling the void space between the excavated ground and the initial support system, if applicable.

6. Safety plan, including a code of safe practices and an emergency plan, for shaft, tunnel, and other underground construction, showing compliance with applicable regulations and laws. Safety plan shall include provisions for protecting the shaft excavation from unauthorized access as required herein.

7. Address and description of disposal site for excess excavated materials that are generated from shaft excavation operations and to be removed from the site.

B. Daily Reports

1. Installation of Initial Support System: On a daily basis during the Work, Contractor shall submit a log of the progress of the installation of the initial support system, including quantity and types of elements installed for each working day, regardless of the amount of progress made. Include number of hours worked, name and classification of crew members, and equipment and materials used. Indicate any downtime and include reason for downtime, duration, and impact of downtime.

2. Shaft Excavation: On a daily basis during the Work, Contractor shall submit a log of materials generated from shaft excavation activities, including a description of soils encountered, pictures, approximate volume (and associated depth of shaft) for each working day, regardless of the amount of progress made. Include the numbers of hours worked, name and classification of crew members and equipment utilized. Indicate quantity and location of groundwater inflows, if encountered. Indicate any downtime and include reason for downtime, duration, and impact of downtime.

C. Provide as-built information associated with the portions of the initial support systems to be left in place, as applicable, and as required herein.

1.06 SAFETY

A. The Contractor's methods of construction shall ensure the safety of the Work, project participants, the public, third parties, and adjacent property, whether public or private. All work shall conform to the applicable requirements of all Federal, State, and local laws and regulations. The Contractor is solely and completely responsible for maintaining safe work conditions at the site at all times.

B. The Contractor's safety officer shall administer an accident prevention program and shall prepare a code of safe practices and an emergency plan. Provide the Engineer with a copy of each prior to starting any shaft or tunnel excavation activities. The Contractor shall hold safety meetings and provide safety instruction for new employees.

1.07 REFERENCES

A. American Society of Civil Engineers (ASCE) - ASCE/CI Standard 36-15, Standard Design and Construction Guidelines for Microtunneling, 2015.

B. ASCE, Geotechnical Baseline Reports for Construction, Suggested Guidelines, 2007.

C. National Fire Protection Code (NFPA) - (NFPA 70, National Electrical Code), latest version.

D. Occupational Safety and Health Administration (OSHA) Safety and Health Regulations for Construction, 29 CFR Part 1926, latest version.

1.08 DEFINITIONS

A. Definitions shall be as stated in ASCE/CI Standard 36-15, Chapter 3 Definitions, unless otherwise modified or supplemented below.

2.00 PRODUCTS

2.01 MATERIALS

A. Structural Steel: Structural steel members, such as fabricated connections and accessories, steel W shapes and other structural steel members, shall be in accordance with ASTM A36, ASTM A572, or ASTM A992.

B. Steel Sheet Piling: Steel sheet piling shall be in accordance with ASTM A328.

C. Concrete: Concrete and other cementitious materials shall be in accordance with ASTM C150. Aggregates used in concrete shall be in accordance with ASTM C33.

3.00 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Each shaft excavation shall be supported in accordance with the corresponding initial support system design as required herein. The Contractor shall perform all Work described herein in accordance with the Shaft Excavation Work Plan as required herein. No shaft construction work, including excavation or installation of initial support system components shall be performed until Engineer has reviewed and accepted all submittals required herein.

B. If settlement of ground or deflections of supports indicates that the initial support system requires modification to prevent such movements, the Contractor shall redesign and modify the initial support system at no additional cost to the Owner.

C. Dimensions of shaft excavations shall be determined by the Contractor to accomplish the Work and accommodate the permanent structures as shown on the Drawings, as required by the Contractor's chosen means and methods for construction, including installation and removal of tunneling and pipe jacking equipment, installation of jacking pipe, and any other subsequent construction, as to minimize conflicts with existing utilities, structures, or other facilities, or as otherwise described herein. No additional payment will be made for additional excavation beyond the required lines of excavation shown on the Drawings, whether the additional excavation occurs as a result of intentional or unintentional excavation.

D. Any shaft excavations performed more than six inches deeper than the elevations shown on the Drawings shall be backfilled with flowable fill at no cost to the Owner.

E. Contractor's means and methods used in the performance of shaft excavations shall not disturb the ground beyond the limits of work.

F. Contractor is fully responsible for maintaining and repairing all shaft excavations and associated initial support systems as required.

G. The site shall be graded and/or berms shall be constructed to promote drainage away from the active shaft excavations.

H. Unsupported Height: No unsupported sidewall spans will be allowed.

I. Welding: All welding shall conform to the applicable provisions of ANSI/AWS D1.1.

3.02 EXISTING UTILITIES, STRUCTURES, AND OTHER FACILITIES

A. The location of existing utilities, structures, and other facilities shown on the Drawings is approximate. The Contractor shall field locate and protect each existing utility, structure, and facility potentially impacted by the Work to verify the exact location of such prior to beginning any shaft excavation activities.

B. Existing utilities in the vicinity of the proposed shaft excavations shall rerouted, with a maximum 24 hours of service disruption or as otherwise acceptable to the owner of such utility. Methods for rerouting shall be acceptable in writing by the owner of the utility. The Contractor shall coordinate with the Owner prior to the planned disruption of service and with each utility owner as necessary prior to relocation, hanging, or upgrade of utilities in the vicinity of shaft excavation. The cost of this work shall be borne by the Contractor, whether performed by the Contractor or the utility owner.

3.03 GEOTECHNICAL INSTRUMENTATION

A. Install and monitor geotechnical instrumentation during performance of shaft excavations in accordance with Section 35 13 54 “Geotechnical Instrumentation and Monitoring.”

3.04 GROUNDWATER AND SURFACE WATER CONTROL

A. Watertight initial support systems shall prevent the migration of sediment and fines into the shaft excavation and shall limit groundwater inflows into each shaft excavation to 0.5 gallons per minute or less. Contractor shall perform repairs of the initial support system or perform grouting of the initial support system, as necessary, to meet the groundwater inflow requirements for each shaft excavation herein at no additional cost to the Owner.

B. Control groundwater and surface water in accordance with Section 33 73 16 – Groundwater and Surface Water Control.

3.05 INTERNAL BRACING OF INITIAL SUPPORT SYSTEM

A. Internal Bracing: The internal bracing of the initial support system shall include wales, struts and/or shores as determined by the Contractor’s initial support system design.

B. Struts: Provide struts with intermediate bracing as needed to prevent rotation, crippling or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

C. Web Stiffeners, Plates and Angles: Include web stiffeners, plates or angles as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

D. Bracing Supports: Install and maintain all bracing support members in tight contact with each other and with the surface being supported.

E. Preloading: Preload bracing members by jacking struts to 50 percent of the design load if necessary to control shoring movement. Preload bracing members in accordance with methods, procedures and sequences as described in the accepted submittals. Coordinate excavation work with installation of bracing and preloading. Use steel shims and steel wedges welded or bolted in place to maintain the preloading force in the bracing after release of the jacking equipment pressure. Install support and preload immediately after installation and prior to continuing excavation.

F. Procedures: Use procedures that produce uniform loading of bracing members without eccentricities or overstressing and distortion of members of system.

3.06 SAFETY

A. A suitable guardrail barrier shall be constructed and maintained, and shall extend a minimum of 42 inches above the ground surface adjacent to each shaft excavation for means of fall protection in accordance with OSHA requirements.

B. Sufficient means of access and egress shall be constructed and maintained for the shaft excavations in accordance with OSHA requirements.

C. A structural steel cover or netting shall be placed at the top of each shaft excavation when there is no construction activity being performed inside the shaft.

D. Each shaft excavation shall be surrounded by a perimeter security fence which shall be secured at any time the site is not occupied by the Contractor's personnel.

E. Provide portable concrete traffic barriers for shaft excavations adjacent to roadways, driveways, or parking lots. Barriers shall be angled in the direction of typical direction of travel and shall not be placed perpendicular to the typical direction of travel.

F. Provide and maintain other traffic control devices in accordance with Federal, State, and local regulations and per other project requirements.

3.07 TOLERANCES

A. The shaft shall be constructed within 0.5 foot of the plan location and elevations shown on the Drawings, if provided.

B. The shaft shall be constructed in its final position not more than one inch out of plumb for every 10 feet of depth of shaft.

C. The centerline of penetrations into the shaft shall not deviate by more than three inches when measured at the inside wall of the shaft.

D. The ovality of the cross section of the shaft excavation at any given plane shall not exceed six inches when measured between any two diameters on a given horizontal plane.

3.08 DISPOSAL OF EXCAVATED MATERIAL

A. All excess excavated materials generated from installation of initial support systems or shaft excavation shall be transported and disposed of in accordance with the applicable Federal, State, and local regulations and per other project requirements.

3.09 REMOVAL OF INITIAL SUPPORT SYSTEM AND BACKFILL

A. All elements of the initial support system within five feet of the proposed finished grade shall be removed, unless otherwise acceptable to the Engineer. Elements of the initial support system greater than five feet below the ground surface shall be removed if practical, or if degradation or decay over time would result in settlement, ground movement, or other damage to adjacent utilities, structures, or other facilities.

B. Removal of the initial support system shall be performed in a manner that will not disturb or harm adjacent construction, utilities, structures, or other facilities and only after backfill has been fully compacted. All voids created by the removal of the initial support system shall be backfilled in accordance with Section 31 23 10 “Structural Excavation and Backfill" or as otherwise acceptable to the Engineer. The portions of the initial support system removed from the excavation shall remain the property of the Contractor and shall be removed from the site and disposed.

C. Furnish, place, and compact backfill in the shafts between the remaining elements of the initial support system. Backfill shall consist of flowable fill, unless otherwise accepted by the Engineer. Backfill adjacent to permanent structures located inside shaft excavations shall be performed in accordance with Section 31 23 10 “Structural Excavation and Backfill.”

D. Contractor shall record dimensions, locations, and elevations of all elements of the initial support system that were not removed from the shaft excavations and shall submit records to the Engineer.

END OF SECTION

33 73 16 GROUNDWATER AND SURFACE WATER CONTROL

1.00 GENERAL

1.01 SCOPE OF WORK

A. Contractor shall design and construct groundwater and surface water control facilities as necessary to maintain the tunnel, shaft, and other excavations free from surface, seepage, and standing water at all times during the performance of excavation and construction activities. Contractor shall remove all components of the groundwater and surface water control systems when no longer required, as acceptable to the Engineer.

B. Contractor shall furnish all labor, equipment, and materials to install and maintain pumps, piping, drains, and other facilities for the control, collection, and disposal of groundwater from tunnel, shaft, and other excavations. Water collected in the tunnel shall be directed to the shafts for collection.

C. Contractor shall furnish all labor, equipment, and materials to perform grading to construct ditches, berms, and other surface water drainage systems necessary to divert and drain surface water away from tunnel, shaft, and other excavations and other work areas. Surface water drainage systems shall be located to not interfere with existing utilities, structures, or other facilities, adjacent properties, adjacent water wells, or construction operations.

D. All Work specified herein is the responsibility of the Contractor, subject to the acceptance of the Engineer. All applicable Federal, State, and local rules, laws, and regulations shall be followed, including those of the Texas Commission on Environmental Quality (TCEQ) involving groundwater and discharges from construction activities, and the Texas Department of Licensing & Regulation (TDLR) involving well drilling and dewatering wells. No part of this specification shall be construed as a relaxation of any of these rules, laws, and regulations.

1.02 RELATED WORK

A. Section 33 13 54 “Geotechnical Instrumentation and Monitoring.”

B. Section 33 23 24 “Contact Grouting.”

C. Section 33 30 00 “Microtunneling.”

D. Section 33 73 15 “Shaft Excavation.”

1.03 QUALITY ASSURANCE AND CONTROL

A. Contractor shall be competent and experienced in performing excavations below the water table and shall submit evidence of at least five years of experience with similar projects. All groundwater and surface water control operations shall be performed under the direct supervision of a qualified superintendent who is assisted by experienced foremen. Both the superintendent and foremen shall have at least five years of experience with similar projects involving tunnel and shaft construction.

B. A detailed, site specific, Groundwater Control Plan shall be prepared, signed and sealed by a Professional Engineer licensed in the State of Texas with a minimum of five years of

experience in the design, installation, and operation of groundwater control systems in similar ground conditions for similar projects involving tunnel and shaft construction.

1.04 PERFORMANCE REQUIREMENTS

A. The Contractor's design and construction of the groundwater and surface water control systems shall be compatible with the ground conditions presented in the GDR and the baseline conditions presented in the GBR.

B. Contractor shall assume sole responsibility for groundwater and surface water control systems, and shall be responsible for any loss or damage resulting from partial or complete failure of protective measures, and any settlement or resultant damage caused by the groundwater and surface water control systems.

C. Contractor shall obtain all necessary permits from agencies that regulate the collection and use of groundwater and surface water and the discharge of collected groundwater and surface water into surface water bodies or storm sewers.

D. Contractor shall protect all shaft excavations from flooding as required by Section 33 73 15 – Shaft Excavation. The Contractor shall monitor river levels and river level forecasts and shall be responsible for notifying personnel and evacuating the site if necessary. The Contractor is responsible for all damages, clean-up, restoration, disposal of fluids and solids, demobilization, re-mobilization, associated with flooding of the site. No adjustment to the contract price will be made for flooding, however a contract time extension may be considered if the flooding causes a delay.

E. Review of the Contractor's submittals for control of groundwater and surface water by the Engineer does not relieve the Contractor, and the engineer retained by the Contractor, of their responsibility to provide and maintain adequate systems for the control of groundwater and surface water meeting the requirements herein.

1.05 SUBMITTALS

A. The Contractor shall obtain and submit copies of permits obtained from Federal, State, or local jurisdictional authorities as required for the Work described herein.

B. Contractor performing dewatering shall submit the resume of the Contractor's superintendent and foremen demonstrating relevant experience as required by Article 1.03.A. herein.

C. The Contractor shall submit a detailed, site specific Groundwater Control Plan to the Engineer for review and acceptance at least 30 calendar days prior to the start of any excavation and/or dewatering activities. The Groundwater Control Plan shall include a narrative, working drawings, and supporting documentation showing the type of groundwater control system proposed for each location for removing, monitoring, treating, and disposing of the collected water. The Groundwater Control Plan shall be signed and sealed by a Professional Engineer licensed in the State of Texas retained by the Contractor. The Groundwater Control Plan shall be coordinated with the Shaft Excavation Work Plan and initial support system designs as required by Section 33 73 15 – Shaft Excavation.

D. The Professional Engineer retained by the Contractor responsible for the Groundwater Control Plan shall submit a resume demonstrating relevant experience as required by Article 1.03.B. herein.

E. Contractor shall submit on a daily basis records of volume of water discharged and other parameters required to be recorded or reported by discharge permits or by agencies having jurisdiction.

1.06 SAFETY

A. The Contractor's chosen means and methods of construction shall ensure the safety of the Work, project participants, the public, third parties, and adjacent property, whether public or private. All work shall conform to the applicable requirements of all Federal, State and local laws and regulations. The Contractor is solely and completely responsible for maintaining safe work conditions at the site at all times.

2.00 PRODUCTS

2.01 GENERAL

A. The Contractor shall have on hand at all times during construction adequate labor, equipment, pipe, power, and supporting materials to maintain the groundwater and surface water control systems as specified herein. Adequate drains, sumps, pumps, and treatment systems shall be provided to facilitate handling, treatment, and disposal of water, and to conform to the requirements for discharge of collected water from construction activities.

3.00 EXECUTION

3.01 GENERAL

A. The Contractor shall install, operate, and maintain the groundwater control systems in accordance with the Groundwater Control Plan. The Contractor shall monitor the effectiveness of the groundwater and surface water control systems and the associated effects of such systems on existing utilities, structures, other facilities, and adjacent property.

B. The Contractor shall furnish, install, operate, and maintain pumps and grading, ditches, berms, and temporary pipes as required to maintain excavations and other work areas free of flowing or standing water and prevent surface water from flowing into excavations. Surface water control systems shall not cause erosion on or off site or cause unwanted flow of water onto adjacent property, roads, or other facilities.

C. When the groundwater or surface water control system does not meet the specified requirements of this section and related specifications, the Contractor shall modify groundwater and surface water control systems or operations of such systems if they cause or threaten to cause damage to existing utilities, structures, other facilities, or adjacent property. The Contractor shall notify the Engineer in writing of any modifications made and provide an updated Groundwater Control Plan to the Engineer as required. The Contractor shall repair any damage caused by the groundwater or surface water control systems to the satisfaction of the Engineer, at no additional cost to the Owner.

3.02 INSTALLATION

A. The location of every element of the groundwater or surface water control systems shall be such that interference with tunnel, shaft, or other excavations and associated construction

activity is minimized. Contractor shall locate wells and all other components of groundwater and surface water control systems in locations which do not adversely affect the Owner or third parties. Locations shall be proposed by the Contractor and acceptable to the Engineer prior to installation.

3.03 OPERATION

A. Unless otherwise accepted by the Engineer in writing, the groundwater and surface water control systems shall be operated by the Contractor continuously 24 hours per day, 7 days per week until tunnel and shafts have been satisfactorily constructed. Contractor shall have sufficient equipment and materials on standby to ensure continuous operation, including a backup power source.

B. Provide filtration to prevent piping, removal of fines, and loss of ground at all points where water is exiting the ground. Filtration shall performed with a properly designed geotextile, engineered sand pack, or similar system designed to provide filtration.

C. For dewatering of material within the interior of watertight initial support systems for shaft excavations, dewatering of shaft excavations shall not be performed until the watertight initial support system has been completely installed.

D. Prior to dewatering of material outside of initial support systems for shaft excavations, Contractor shall install at least three piezometers and other instrumentation as necessary adjacent to each shaft excavation prior to performing any dewatering, or as otherwise required by the Contractor's engineer responsible for the design of the groundwater control system. These piezometers and other instrumentation shall be used to monitor dewatering operations and assure that the required results are achieved. Piezometers or other instrumentation shall be installed, monitored, and maintained in accordance with the applicable requirements of Section 33 13 54 – Geotechnical Instrumentation and Monitoring. Such piezometers and other instrumentation shall be installed in separate boreholes than those boreholes used as dewatering wells.

E. Any groundwater or surface water contaminated by the Contractor's operations or collected during excavation operations, shall be collected in tanks or settling basins to filter solids prior to discharge. Contractor shall settle out solids and perform other methods of treatment prior to discharging collected groundwater or surface water into surface water bodies or storm sewers as required by permits obtained by the Contractor and agencies having jurisdiction. Contractor shall dewater the solids that are collected and dispose of them as required by the Contract Documents.

3.04 REMOVAL

A. All elements of the groundwater and surface water control system, including piezometers and other instrumentation, shall be removed from the site at the completion of the tunnel and shaft construction work as acceptable to the Engineer. For any piezometers and other instrumentation installed, such shall be removed in accordance with the applicable requirements of Section 33 13 54 – Geotechnical Instrumentation and Monitoring.

END OF SECTION

40 05 43 MISCELLANEOUS VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install miscellaneous valves complete and ready for operation as shown on the Drawings and specified herein.

B. The equipment shall include, but not be limited to, the following; however, not all items specified herein may be included in this Project.

1. General Requirements.
2. Thermoplastic Valves:
    a. Ball Valves – PVC/CPVC.
3. Yard Hydrants.
4. Solenoid Valves.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings.
2. Operation and Maintenance Manuals.

1.03 GUARANTEE AND WARRANTY

A. Manufacturer shall warrant the equipment and materials furnished under this Section against defects in materials and workmanship and operational failure for a period of 1 year from the date of Owner acceptance.

B. In the event of failure of any part or parts of the equipment during the first year of service, provided that the equipment has been operated and maintained in accordance with good practice, the Manufacturer shall furnish and deliver a replacement for the defective part or parts at the Manufacturer’s own expense. Manufacturer is also responsible for equipment freight.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM A48 - Standard Specification for Gray Iron Castings
3. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
4. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels

5. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes
6. ASTM A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
7. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings
8. ASTM A536 - Standard Specification for Ductile Iron Castings
9. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form
10. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings
11. ASTM B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
12. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications
13. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
14. ASTM F1970 - Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems

B. American Water Works Association (AWWA):
   1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   2. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly
   3. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
   4. AWWA C800 - Underground Service Line Valves and Fittings

C. American National Standards Institute (ANSI):
   1. ANSI ASSE 1013 - Performance Requirements For Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
   2. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals)
   3. ANSI B16.1/B16.5 - Pipe Flanges and Fittings Package
   4. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves

D. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):
   1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions
   2. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services
   3. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

1.05 QUALITY ASSURANCE

A. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 years of experience in the manufacture of the valves.

B. Uniformity Requirements: Units of the same type shall be the product of one manufacturer.

C. Inspection of units may also be made by Engineer or other representative of Owner after delivery. Equipment shall be subject to rejection at any time due to failure to meet any of specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from job site at once.

2.00 PRODUCTS

2.01 GENERAL

A. Valves and appurtenances shall be of size shown on the Drawings or as noted.

B. Valves and appurtenances shall have name of maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or via riveted stainless steel nameplate upon some appropriate part of the body.

C. Unless otherwise noted, all valves and fittings shall have a minimum working pressure of 150 psi or shall be rated for the test pressures associated with the pipe they connect to, whichever is higher.

D. Joints, size and material - unless otherwise noted or required by Engineer:

1. Except where noted, joints referred to herein shall be of same type, nominal diameter, material and with a minimum rating equal to pipe or fittings they are connected to.

2. Valves and appurtenances shall be of same nominal diameter as pipe or fittings they are connected to.

E. Despite any of these specified requirements, coatings and lubricants in contact with potable water shall be NSF61 certified as acceptable for use with that fluid.

F. Unless otherwise noted, interior ferrous surfaces of valves shall be given a shop finish of an epoxy conforming to AWWA C550 with a minimum thickness of 6 mils.

G. Exterior surface of various parts of valves, operators, floor stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter; and thereafter, one shop coat of an approved rust-inhibitive primer shall be applied in accordance with Division 9.

H. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment. Tools shall be packaged, clearly and permanently marked on the exterior to indicate equipment for which tools are intended.

I. Provide special adaptors as required to ensure compatibility between valves, appurtenances, and adjacent pipe.

J. Where valve handwheels are installed with a centerline higher than 6 feet, the valve shall be installed in an orientation and equipped with a chainwheel to allow for operation from standing at grade. Chain and accessories shall be stainless steel. Chain wheels shall be:

1. Ductile iron coated per Section 09 91 00.01 “High Performance Coatings;” or
2. Stainless steel.

2.02 THERMOPLASTIC VALVES

A. Ball Valves - PVC/CPVC:

1. Materials:
    a. Body: Valves shall be manufactured to ASTM F1970 and constructed from one of the following:
        1). PVC Type 1, ASTM D1784 Cell Classification 12454-A.
        2). CPVC Type IV, ASTM D1784 Cell Classification 23447-B or 23567-A.
    b. Seats shall be Teflon Polytetrafluoroethylene (PTFE) with elastomeric backing O-ring cushions to provide smooth even stem torque and to compensate for wear.
    c. Seals shall be made of Viton Fluorocarbon Rubber (FPM/FKM) or ethylene propylene diene terpolymer rubber (EPDM), as required for chemical compatibility.
2. Valves shall be PVC or CPVC construction to match adjacent piping unless specifically noted or called out on the Drawings.
3. All valve stems shall be equipped with a double O-ring.
4. The valve shall be capable of blocking in two directions (upstream and downstream), leaving full pressure on the opposite end of the valve.
5. End Connection:
    a. 2-1/2 Inches and Smaller: True Union.
    b. 3 Inches and Larger: Flanged.
6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Chemtrol TU Series Ball Valves.

2.03

2.03 YARD HYDRANT

A. Yard Hydrant shall be automatically draining, backflow protected with standard 3/4-inch garden hose thread outlet and lever handle.

B. Depth of bury shall be 2 feet.

C. Yard hydrants shall be coated per Section 09 91 00.01 “High Performance Coatings.”

D. Subject to compliance with requirements, yard hydrants shall be:

1. Woodford Model Y2;
2. Jay R. Smith Figure Number 5909;

3. Zurn Z1395; or

4. Engineer approved equivalent.

2.04 SOLENOID VALVES

A. Solenoid valves shall be packless piston type, direct acting for sizes less than 2-inch and internal pilot operated for sizes 2 inches and larger; 2-way or 3-way valves. All solenoids shall be NEMA 4X rated and shall be ASCO Valve; Red Hat by Automatic Switch Co.; similar by Circle Seal Controls-Atkomatic Valve Co., for air and water service.

B. Valves shall be energized to open, except for valves on water seal lines to pumps, which shall be energized to close.

C. Valves shall be Type 316 stainless steel bodies, NPT end connections of connected piping, Type 304 stainless steel internal parts, and Buna-N or Ethylene Propylene valve seats. Valves shall have a minimum 150-psig safe working pressure and zero minimum operating pressure differential. Connections shall be threaded.

D. Solenoid valves size 3 inches and larger shall be full bore bronze body, Type 430 stainless steel plunger, copper coil Class A encapsulated, Type 302 stainless steel spring, wash-down safe, equal to Type A as manufactured by Magnatrol Valve Corp., Hawthorne, NJ, or equal.

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and install valves in a manner that prevents damage to any part of the valves. Install valves in accordance with the Manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of the equipment, conduct an acceptance test to verify the satisfactory operation of each unit. The test shall be conducted in a manner approved by and in the presence of the Engineer and/or Owner. The unit shall be checked for general operation and leakage. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

END OF SECTION

40 05 50 FABRICATED GATES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to fabricate, test and install slide gates as shown on the Drawings and indicated in gate schedule with operators, gate stems, frames, gate guides, wall thimbles and other related appurtenances.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Whipps.
2. Fontaine.
3. Golden Harvest.

B. Manufacturer's Representative for Startup and Testing: The services of the manufacturer's technical representative shall be provided for pre-startup installation checks, startup assistance, training of Owner's operating personnel, troubleshooting and other services as required in Section 01 75 00 "Starting and Adjusting."

C. The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. Manufacturer shall provide test certificates to show that they meet the leakage rate required in this Section. Factory hydrostatic testing shall be conducted to the maximum design head of each specific gate, per Paragraph **[3.04.A]**. There shall be no assembling or adjusting on the Site other than for the lifting mechanism

1.03 MANUFACTURER'S QUALITY CONTROL SYSTEM

A. The gate manufacturer shall be ISO 9001 certified and compliant or have an approved Quality Assurance Policy.

1.04 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include at least the following:

1. Shop Drawings:

a. Certified shop and installation drawings showing all materials, details of construction, dimensions and anchor bolt locations. General arrangement drawings and catalog cut sheets are not acceptable for use as shop and installation drawings.

b. Maximum deflection and bending stress of the slide and frame of each sluice gate loaded under the maximum design head.

c. Submit a list of not less than 10 operating installations in the United States with similar size gates as scheduled, as evidence of meeting the experience requirement. Include project reference contact information.

2. Record Data:

    a. Descriptive literature, bulletins and/or catalogs of the equipment.

    b. Prior to shipment of gates, submit certified affidavit of compliance stating that the gates for this Contract were manufactured, inspected, and tested in accordance with all applicable AWWA and ASTM Standards.

    c. Shop test reports, including test results from operation and shop leakage tests on all gates. Leakage tests shall be performed with water in the unseating head condition. Feeler gauge testing is not acceptable in lieu of testing with water.

    d. ISO 9001:2015 certification or paperwork confirmation a similar QA/QA program.

3. Operation and Maintenance Manuals: O&M manual instructions are provided in Section 01 33 04 “Operation and Maintenance Data.”

1.05 STANDARDS

A. The applicable provisions of the following standard shall apply as if written here in its entirety unless expressly contradicted in the text of this specification:

1. American Water Works Association (AWWA): AWWA C561-14, Fabricated Stainless Steel Slide Gates (latest revision).

2. ASTM International (ASTM).

3. American Welding Society (AWS).

1.06 EXPERIENCE REQUIREMENTS

A. The equipment Supplier shall have at least 10 years of experience in the design, application and supply of stainless steel fabricated gates in water service. The equipment supplier shall submit a list of not less than 10 operating installations in the United States with similar size gate as scheduled, as evidence of meeting the experience requirement. Installation list shall be submitted with the Shop Drawings.

1.07 GUARANTEE AND WARRANTY

A. Gate Manufacturer shall warrant the equipment furnished under this specification for a minimum period of **2** years against defects in materials and workmanship, and operational failure.

B. In the event of a defect in material or workmanship or equipment design of any part or parts of the equipment during the first **2** years of service, provided that the equipment has been operated and maintained in accordance with good practice, the Gate Manufacturer shall furnish, deliver and install a replacement for the defective part or parts at its own expense.

C. The first **2** years of service shall be interpreted as the **24**-month period following the installation, adjusting, and acceptance tests of all gates, operators, motors and appurtenances.

2.00 PRODUCTS

2.01 MATERIALS

A. Materials in fabricated gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

1. Carbon Steel Bars: ASTM A108 or ASTM A575.
2. Structural Steel Shapes, Plates, and Bars: ASTM A36.
3. Stainless Steel: ASTM A167, ASTM A276 or ASTM A582, Type 302, 303, 304 or 304L, 316 or 316L.
4. Bronze Bar, Rods, Shapes: ASTM B21 or ASTM B98.
5. Cast Bronze: ASTM B584.
6. Rubber for Gaskets and Seals: ASTM D2000, Grade R-62.
7. UHMW Polyethylene: ASTM D4020.

2.02 GATE DEFINITIONS

A. Sluice gates are defined as fabricated gates with top, bottom and side seals. Sluice gates are typically used at pipe ends in basins or influent and effluent boxes and fully submerged wall openings and/or orifices.

B. Slide gates are defined as fabricated gates with bottom and side seals. Slide gates are typically used for open channel isolation and diversion. The top of slide gates are typically above the maximum water surface elevation. Slide gates are not suitable for submerged orifice applications.

C. Weir gates are defined as fabricated gates with bottom and side seals. Weir gates are typically used as overflow downward opening adjustable weirs. The top of weir gates are typically submerged and set at the desired overflow elevation. Weir gates are mounted flush to the wall surface at the weir opening in the structural wall.

D. Stop gates and stop logs are defined as hydraulic control gates where their use is more permanent and requires infrequent opening and closing. Stop gates and stop logs are used to provide a permanent flow control across an opening and operate similar to an adjustable weir gate. Stop gates typically consist of a single continuous slide while stop logs consist of several smaller equal size “logs” that can be installed or removed as needed to change the height of gate.

2.03 FABRICATED GATES

A. General:

1. Gates shall be as specified herein and have the characteristics and dimensions shown on the Contract Documents and schedule. Any discrepancies shall be brought to the attention of the Engineer.
2. Leakage for fabricated gates shall not exceed 0.05 gpm/ft of wetted seal perimeter in seating and unseating head conditions.

3. The maximum allowable leakage for stop gates and stop logs shall be 0.1 gpm/lf of wetted seal perimeter in seating and unseating head conditions.
4. The gate seal design shall meet the latest applicable AWWA standards.
5. All structural components of the frame and slide shall be constructed of fabricated stainless steel having a minimum thickness of 1/4 inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.
6. All welding shall be performed by welders with AWS or ASME Section IX certification and be completed in the manufacturing facility. No welding is allowed in the field during installation.
7. Fabricated components shall be passivated in accordance with ASTM A380 to remove weld burn and discoloration for uniform finish. If sandblasting or glass bead blasting is utilized, the entire frame and slide shall be blasted for a uniform finish.
8. Materials:

Components	Materials
Frame Assembly and Retainers	304L stainless steel. See Paragraph 3.04
Slide and Stiffeners	304L stainless steel. See Paragraph 3.04
Stem	304L stainless steel. See Paragraph 3.04
Fasteners, Nuts and Bolts	316 stainless steel
Invert Seal (Upward Opening Gates Only)	EPDM or Neoprene
Seat/Seals and Facing	UHMWPE. See Paragraph 3.04
Lift Nuts	Bronze
Pedestal and Wall Brackets	Stainless steel
Operator Housing	Aluminum

B. Frames:

1. Frame shall be of flange-back design for wall mounted gates and formed or extruded construction consisting of guides and invert members and top member where top closure is required. Suitable reinforcements will be provided to resist all operating loads. The mounting and bolting flange of the frame to the wall shall be separate and independent from the seating and sealing plane of the slide.
2. Frame shall be designed for various mounting styles as shown on the Drawings.
3. The structural portion of the frame that incorporates the seat/seals shall be formed into a one-piece shape for rigidity. Gussets shall be provided on the guides to transfer the load from unseating head conditions to the wall. Guide member designs where water loads are transferred through the assembly bolts are not acceptable.
4. The portion of the wall mounted guide, where the anchor bolt penetrates, shall have a minimum thickness of 1/2-inch. Guide extensions shall be formed plate C-channel or Z-channel members and shall have a minimum weight of 6 lb/ft. Angles are not acceptable as guide extensions. Alternatively, the manufacturer may supply frames

with a flange-back design utilizing fully welded gusset plate stiffeners, minimum 1/4-inch thickness in order to limit the frame deflection to lesser of 1/360 x L or 1/16 inch.

5. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by two C-channel shaped structural members affixed to the top of the side frame members to provide a one-piece rigid assembly. The yoke shall be designed to allow removal of the slide. The maximum deflection of the yoke shall be 1/360 of the gate's span or 1/16 inch, whichever is less.
6. A rigid stainless steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flushbottom type on upward opening gates. Flushbottom seal shall incorporate an embedded frame channel gate for new construction or an existing channel gate mount for existing channels.
7. A rigid stainless steel top seal member shall be provided across the top of the opening on gates designed to cover submerged openings.
8. The frame shall be capable of withstanding lateral forces as appropriate in this configuration as well as during the extraction of the slide with lifting cables at angles of up to 10 degrees.

C. Slides and Guides:

1. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of 1/4 inch.
2. The gate slide deflection shall not exceed 1/360th of gate width at maximum design head or 1/16 inch, whichever is less.
3. Reinforcing stiffeners shall be welded to the slide and mounted horizontally. Vertical stiffeners shall be welded on the outside of the horizontal stiffeners for additional reinforcement.
4. The stem connector shall be constructed of two angles or plates. The stem connector shall be welded to the slide. A minimum of two bolts shall connect the stem to the stem connector.
5. The gate guides shall be designed for maximum rigidity, having a weight of not less than 2-1/2 pounds for aluminum stop gates, 4.5 pounds for aluminum slide gates, and 9 pounds for stainless steel. The guides shall be of sufficient length to properly support two-thirds of the height of the slide when the gate is fully open. On self-contained gates, where the guides extend above the operating floor, they shall be strong enough so that no further reinforcing shall be required.
6. Downward opening weir gates shall have a self-containing frame that extends beyond the weir elevation so that the top of gate slide elevation is at or lower than the weir elevation when fully open.
7. Each gate frame shall be fabricated with two integrated lifting lugs or eyes capable of supporting the entire weight of the gate assembly. The location of the lifting points shall be determined by the manufacturer for lifting from above.

D. Gate Stem and Lift:

1. Stems shall be of suitable length with minimum 1.5-inch diameter, and ample strength for the intended service. The operating stem shall be rising. The stem diameter shall be

capable of withstanding twice the rated output of the operator at 40 pounds crank or hand wheel pull and shall be capable of moving the gate slide with the specified seating and unseating head against the gate.

2. The stem shall be furnished in sections of sufficient length to completely open the gate as necessary and to permit reasonable ease transportation and in installation. Couplings shall be stainless steel and shall be bored and bolted or pinned. Stem threads shall be machine rolled or machine-cut full depth ACME threads. The threads shall be smooth and of uniform lead and cross-section, such that the nut can travel the full length without binding or excessive friction. The stem shall be provided with two bolt holes for connection to the stem connector on the slide or the stem shall be threaded for connection to the stem block or thrust nut on the gate slide. The entire stem shall be of solid stainless steel material and the threaded portion of the stem shall have a rolled or machine cut full depth, full depth ACME threads with a 16-microinch finish or better. Stem extension pipes are not acceptable unless specifically required by the Contract Documents and approved prior to installation by the Engineer.
3. Stem guides shall be fabricated from stainless steel with UHMWPE bushed collars and adjustable in two directions**.** Stem guide spacing shall be as recommended by the manufacturer, but in no case shall it exceed 9 feet-0 inches center to center spacing.
4. An adjustable aluminum, bronze, or stainless steel stop collar shall be provided to limit both upward and downward travel of the fabricated gate. The stop collar shall be internally threaded and provided with a stainless steel set screw. Removable upstops and downstops can also be provided on the slide and frame.
5. Provision shall be made to prevent stem rotation within the thrust nut at the connection with the gate slide.

E. Seals:

1. All gates shall be equipped with self-adjusting UHMW polyethylene side and bottom seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.
2. Upward opening gates requiring top closure shall be provided with self-adjusting UHMW seals across the top seal member. Downward opening gates shall be provided with self adjusting UHMW seals along the invert member.
3. The seat/seals shall extend the full height of the frame and guides to accommodate the height of the slide when the slide is in the fully closed or fully opened position.
4. The seal system shall be durable and shall be designed to accommodate high velocities and frequent cycling without loosening or suffering damage.
5. Wall mounted upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and it shall be held in place with stainless steel attachment hardware.
6. All seals must be bolted or otherwise mechanically fastened to the frame or slide. All seals must be field replaceable without the need to remove the gate frame from the wall or without the need to remove grout. Arrangement with seals that are force fit or held in place with adhesives are unacceptable.

7. The seals shall be mounted so as not to obstruct the gate opening.
8. The seal system shall be factory tested to confirm negligible wear (less than 0.02 inches) and proper sealing.
9. Neoprene J-type seals are not acceptable.

F. Manual Operators: Unless otherwise indicated in Paragraph 3.04, gates shall be operated by a crank-operated gearbox. The operator shall be mounted on the yoke of self-contained gates or on the pedestal of non-self-contained gates.

1. The gate manufacturer shall select the proper gear ratio to ensure that the gate can be operated with no more than a 40-pound effort when the gate is in the closed position and experiencing the maximum operating head.
2. An arrow with the word “OPEN” shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate.
3. Manufacturer shall provide the appropriate operator crank-operated gearbox at 36 inches above operating floor unless noted otherwise in the schedule or the Drawings.
4. Crank-operated gearboxes shall be fully enclosed and shall have a cast aluminum housing.
    a. All gearboxes shall have input shafts suitable for operation via a portable operator.
    b. Gearboxes shall have single gear reduction.
    c. Gearboxes shall be provided with a threaded cast bronze lift nut to engage the operating stem.
    d. Bearings shall be provided above and below the flange on the operating nut to support both opening and closing thrusts.
    e. Gears shall be steel with machined cut teeth designed for smooth operation.
    f. The pinion shaft shall be stainless steel and shall be supported on ball or tapered roller bearings.
    g. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.
    h. The crank shall be cast aluminum with a revolving nylon, or aluminum grip.
    i. The crank shall be removable. Provide a minimum of one crank for every gateunless otherwise approved by the Engineer.
5. Pedestals shall be constructed of stainless steel. Aluminum pedestals are not acceptable.
    a. The pedestal height shall be such that the handwheel or pinion shaft on the crank-operated gearbox is located 36 inches above the operating floor.
    b. Wall brackets shall be used to support floor stands where shown on the Drawings and shall be constructed of stainless steel.
    c. Wall brackets shall be reinforced to withstand in compression at least two times the rated output of the operator with a 40-pound effort on the crank or handwheel.

d. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the Engineer. The gate manufacturer shall supply the bracket, anchor bolts and accessories as part of the gate assembly.

6. Operators shall be equipped with fracture resistant clear butyrate or lexan plastic stem covers.

   a. The top of the stem cover shall be closed.

   b. The bottom end of the stem cover shall be mounted in a housing or adapter for easy field mounting.

   c. Stem covers shall be complete with indicator markings to indicate gate position.

   d. Vent holes shall be provided to prevent condensation.

   e. Cover shall not become brittle or discolored when subjected to local weather conditions for a minimum of 5 years after installation. Replacement of covers less than 5 years after installation shall be provided under warranty.

3.00 EXECUTION

3.01 INSTALLATION

A. Fabricated gates shall be installed in accordance with the recommendations of the gate manufacturer. Guide frames for fabricated gates shall be as shown on the schedule. The bottom of the fabricated gate structure shall be embedded flush bottom, unless otherwise indicated.

B. Install the gates in a manner that will prevent leakage around the frame and will prevent binding of the slide during operation. Keep surfaces where metal and the concrete placed come in contact free from oil, grease, loose mill scale, loose paint, surface rust, and other debris or objectionable coatings. Secure anchor bolts, thimbles and spigot frames in true position in the forms and hold in alignment during the placement of the concrete. Finish surfaces to provide a smooth and uniform contact surface where concrete and rubber seals come in contact and where frames or plates are installed. When a gate or stop log frame is installed against concrete, the Contractor shall either install using double-nuts and a nominal 1-inch grout pad or a minimum 3/8-inch thick 1/2-inch EPDM mounting gasket or 1/2-inch non-shrink grout shall be placed between the gate and the concrete. When the gate is attached to a thimble, apply a gasket and mastic between the face of the thimble and the gasket and the gasket and the gate frame. Apply the mastic between the wall thimble stud holes and the gate opening. If a gasket is utilized, the installer must ensure that the surface around the opening is sufficiently flat per the manufacturer's instructions.

C. Carefully align gate stems, stem guides and gate lifts so the stem is parallel to the guide bars or angles on the gate frame after installation.

3.02 FIELD QUALITY CONTROL

A. Prior to final acceptance by the Owner, the slide gates shall be tested in the presence of the Engineer. A seating head and/or unseating head, at the Engineer's request, corresponding to the maximum water level shall be placed on the slide gate and the gate examined for leakage. The maximum allowable leakage for fabricated gates shall be per Paragraphs

2.03.A.2 and 2.03.A.3. Manufacturer shall provide test certificates to show that they meet the leakage rate required in this Section. The slide gate shall be opened from the fully closed position under maximum seating head, and closed from the fully open position under average flow conditions to verify that the gate lift is operational and in satisfactory working order.

3.03 CLEAN AND ADJUST

A. After installation, clean, lubricate, and otherwise service the gate and lift in accordance with the manufacturer's instructions.

3.04 SCHEDULES

A. Fabricated gates shall be supplied in accordance with the following schedule: The required gates and certain pertinent data are given below. This list is given to facilitate description of the various gates and as an aid to plan take-off, and is not guaranteed to be complete.

No. Req.	Location/ Service	ID Tag	Opening Size	Opening Direction	Gate Type	Gate Material	Mount	Seating/ Unseating Head (feet)	Operator Type
1	Lawson Pump Station Forebay	SLU-0101	48" x 48"	Upward	SLU	316SS	EW PC WM	18	MAN
1	Collier's Ferry Pump Station Wet Well	SLU-0201	48" x 48"	Upward	SLU	316SS	CW PC WM	24.4	MAN

LEGEND	
Opening Direction	Upward (Fabricated Gates) Downward (Weir Gates)
Gate Type	Slide Gate (SLD) Sluice Gate (SLU) Stop Gate (STP) Weir Gate (WRG)

LEGEND	
Mount	Existing Structure Existing Channel Mount (EC) Existing Wall Mount (EW) New Structure Frame Embedded Mount (FE) Wall Thimble (WT) Concrete Wall Mount (CW) End of Pipe Pipe Flange (PF) Flush Pipe in Concrete Wall (PC) Bottom Seal Chanel Mount (CB) Wall Mount (WM)
Operator Type	Motor (MTR) Manual (MAN) Stem Nut (STM)

END OF SECTION

40 05 53 IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide identifying devices for the following:

1. Piping.
2. Equipment.
3. Electrical Equipment.
4. Valves.
5. HVAC equipment.
6. Fire sprinkler and piping.
7. Control devices.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Product data sheets for identifying devices.
2. A list of where devices are to be installed, and the data to be included on each identifying device.

1.03 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) Standards:

ANSI A13.1	Pipe Marking Specifications

1.04 DELIVERY AND STORAGE

A. Store products inside storage sheds until installed.

1.05 GUARANTEES

A. Guarantee Identifying devices installed in wet locations or areas subject to moisture to be weather resistant for a period of 3 years after installation.

2.00 PRODUCTS

2.01 MATERIALS

A. Piping Identification: Pressure sensitive, adhesive-backed vinyl plastic label having the lettering indicated on background color as scheduled. Provide labels manufactured by the

Seton Name Plate Corp. or Brady “Perma Code”. Provide labels having an arrow to indicate the direction of flow. Provide 1-1/4-inch high letters.

B. Outdoor Pipe Markers: Seton “Weather Code” Fade resistant, vinyl markers, 2-1/4 by 9 inches.

C. Valve Identification: Provide Seton Style 250-BL Black Filled, 1-1/2-inch round, brass tag with proper identification stamped on tag. Tag shall have the proper prefix followed by a code number that is unique and identifies the valve from all others in the project. Provide hole in top of tag for mounting chain. Provide brass jack chain, copper metal meter seals, or brass “S” hooks as appropriate.

D. Equipment Nameplate: Seton Style 2060 “Seton-ply” engraved plastic plaque, approximately 3/4 by 2-1/2 inches in size. Plaque shall be 1/16 inch thick having beveled edges and drilled with two mounting holes when attached by screws. Mounting screws shall be stainless steel. Lettering shall be approximately 3/16 inch high. Text to include equipment mark and equipment description (Example: EXHAUST FAN EF-5). Identification label on nameplate shall correspond to a typewritten legend included in the O & M Manual which includes the following:

1. Equipment identifier.
2. Location inside building (or on project site).
3. Manufacturer’s model number.
4. Brief description of function.
5. Reference to shop drawings, parts lists, or other data included in the O & M Manual.

E. Fire Sprinkler System Signs: Signs for fire protection system shall conform to NFPA-13 and shall be equal to Seton Style SFB, furnished in porcelain with “white on red” color.

3.00 EXECUTION

3.01 PREPARATION

A. Install piping complete with insulation and valves in place prior to installing identification devices. Mount electrical components, including electrical control devices. Piping shall be dry and free of oil, grease, or other contaminants. Insulation shall be completely dry.

3.02 INSTALLATION

A. Install pipe labels on piping exposed to view, in any location inside buildings or structures, or in underground vaults, pump stations, basements, or other exposed locations.

B. Install a minimum of one label in each area or room and additional labels at spacings not to exceed 5 feet. Position labels so that lettering is visible from the front of piping at floor level. Provide labels of a size that is legible from floor level. Install labels in rows with uniform spacings where several pipes run parallel to each other.

C. Name the fluid flowing inside the pipe on color coded labels with text per the schedule below. Labels shall also include an arrow indicating the direction of flow.

3.03 VALVE IDENTIFICATION

A. Install a valve tag on all valves. Attach the tag to hand wheel of valve stem so that it does not interfere with operation of valve tag brass link chains or copper meter seals furnished by the Tag Manufacturer.

B. Number valves to correspond to a typewritten list included in the Operational and Maintenance Manual and include the following information:

1. Valve Number.
2. Description of piping fluid or purpose.
3. Normal position of valve (Open or Closed).
4. Manufacturer's catalog number.
5. Brief description of valve specification.
6. Brief description of valve's function in the system.

C. Valve identification shall be based on the following example:

Valve Number	Function	Location	Normal Position	Mfg's Cat No.	Valve Type	Description
P-1	Domestic Water	Rm. 103	Open	Crane Fig. 315C	Gate rising stem	Shut off to heater

3.04 EQUIPMENT IDENTIFICATION

A. Provide an equipment identifier on each separate piece of equipment, including process equipment, HVAC equipment, plumbing equipment (other than plumbing fixtures), and electrical equipment. Provide a nameplate for each separate piece of electrical equipment, including but not limited to panelboards, switchgear, starters, disconnects, control devices and control panels. Provide name tags for each separate switch, starter, contactor, or other compartment on electrical switchgear.

B. Engrave lettering on nameplates corresponding to the identification marks. Install nameplates prominently on equipment not occurring in occupied spaces. Install nameplates on the inside covers of lighting panelboards. Install nameplates on all other equipment centered and at top of equipment. Nameplates shall not be installed in a location that interferes with the equipment's ability to operate.

C. Attach nameplates to exterior equipment with two 3/8-inch stainless steel screws. Interior plaque may be attached by screws, or by the adhesion method when approved by the Engineer.

3.05 ELECTRICAL OUTLET

A. Provide a nameplate for electrical outlet listed below. The nameplate shall be white letters on red background, and shall specify the outlet's voltage and ampere rating. The nameplate on special outlets shall have an appropriate warning. Lettering shall be 1/8 inch high. Overall plate size shall be approximately 3/4 by 2-1/2 inches.

B. Provide nameplates on the following:

1. 208/240 outlet: voltage and ampere rating.

2. Special outlet: voltage, ampere rating and intended function (Example: Welder Outlet 240 V – 40 A).

3.06 POTABLE AND NON-POTABLE WATER

A. Provide name tags at every water hydrant or outlet. Fabricate name tags of 3/4-by-1-1/2-by-1/8-inch aluminum with a medium, duranodic finish and plexiglas face panel. The face panel shall have 1-inch high, white, helvetica medium lettering on blue background stating "Potable Water", or white lettering on green background stating "Non-Potable Water". Place signs on walls above the hydrant locations and attach to backplates. Yard hydrants shall have concrete piers which are 6 inches in diameter by 36 inches with signs attached to the face of the concrete directly in front of the hydrants. Extend the piers 4 inches minimum above finish grade. Signs shall be manufactured by Vomer Products, Inc., equal to Vocator Exterior sign series E9/12.

3.07 SCHEDULES

A. Prepare a typed schedule showing piping label requirements, valve tag identification, and equipment tags. Include each valve or piping type and the appropriate identification on the schedule. Submit the schedule to the Engineer for approval.

B. Mark valve tags and pipe labels to conform with the following legend, or with requirements of standards noted. Include the full name, as appearing under the column heading "Description", and the abbreviation under the column heading "Abbrev. Legend."

Description	Valve Prefix	Abbrev. Legend	Label Color (Letter on Background)
Plumbing			
Water, Non-potable	N	NPW	Black on Green
HVAC			
Refrigerant, Suction	H	RS	Black on Green
Refrigerant, Liquid	H	RL	Black on Green
Condensate	H	CD	Black on Green
Electrical			
Panelboards	LP-1		White on Black
Starters for Exhaust Fan	S/EF-1		White on Black
Control Panels for Exhaust Fan	CP/EF-1		White on Black
Disconnects for Exhaust Fan	DS/EF-1		White on Black
Junction Boxes	JB/101		White on Black
Controllers for Exhaust Fan	CI/EF-1		White on Black

C. Piping Color Schedule:

Description	Pipe Color
Potable Water	Light Blue
Compressed Air	Light Green
Instrument Air	Light Green with Dark Green Bands
Chlorine (gas, liquid, or vent)	Yellow
Chlorine (solution)	Yellow with Red Bands
Liquid Alum	Yellow with Orange Bands
Alum (solution)	Yellow with Green Bands
Ammonia	Yellow with Brown Bands
Chlorine Dioxide (solution)	Yellow with Blue Bands
Ferric Chloride	Brown with Red Bands
Ferric Sulfate	Brown with Yellow Bands
Polymers	White with Green Bands
Liquid Caustic	White with Red Bands
Caustic (solution)	White with Orange Bands
Fluoride	White with Yellow Bands
Ozone	Stainless Steel with White Bands
Settled Water	Green
Filter Effluent	Light Blue
Backwash Supply	Light Blue
Drain	Dark Grey
Raw Water	Tan

END OF SECTION

40 05 61 GATE VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install gate valves and appurtenances, including valve boxes, operators, bolts, nuts and gaskets.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. American-Flow Control.
2. M&H.
3. Mueller.
4. Clow.
5. U.S. Pipe

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Operation and Maintenance Manuals.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

2. American Society for Testing and Materials (ASTM) Standards:

ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Standard Specification for Ductile Iron Castings

3. American Water Works Association (AWWA) Standards:

AWWA C111	Rubber-Gasket Joints
AWWA C500	Gate Valves for Water and Sewage Systems
AWWA C509	Resilient Seated Gate Valves for Water and Sewage Systems

2.00 PRODUCTS

2.01 GATE VALVES

A. General:

1. Unless otherwise specified, gate valves greater than 24 inches in size shall be in strict accordance with AWWA C500. Gate valves shall be double disc, parallel seat internal wedging type with non-rising stem. Unless otherwise specified, gate valves 3 through 24 inches in size shall be in accordance with AWWA C509, Resilient Wedge. Valves 16 inches and larger shall be provided with gearing to reduce the maximum required opening and closing torque to 80 ft-lb.

2. Gate valves 2-1/2 inches and smaller shall be bronze, non-rising stem with wedge disc and screwed ends for 300-psi W.O.G. working pressure. Bronze gate valves shall be Crane No. 437, Mueller No. H 10914, or approved equal.

3. Gate valves 30 inches and larger shall be equipped with non-rising stem bypass valve and with spur-gears in enclosed oil or grease lubricated gear cases. Gear boxes shall be factory lubricated. Flanges shall conform to ANSI, Class 125 or 250.

B. Gate: Gate for double disc valves shall be cast iron with bronze mounted wedges and seats. Gate for resilient seated valves shall be cast iron with rubber-seat compound bonded to the valve gate.

C. Operators: Operators shall turn counterclockwise to open the valve. Exposed valves shall have handwheel operators unless otherwise designated. A directional arrow and the word "open" shall be cast on the handwheel. Valves for buried service shall have a 2-inch square nut operator and shall be installed with extension stems where required to extend operating nut to within 12 inches of the finished grade. Provide a cast iron valve box to enclose the operating stem. Valve box shall be three-piece extension type equal to Mueller No. 10380 or Clow F2450.

D. Stem and Seal: The non-rising stem shall be bronze with inside screw. Shaft seal shall employ O-rings or V-type packing.

E. Bell Ends: Where designated, valves shall be mechanical joint or rubber gasketed push on joints in accordance with the applicable requirements of AWWA C111.

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and lower buried valves into position to prevent damage to any part of the valves. Place the valve in the proper position with stem truly vertical and securely hold until connections have been made. Furnish bolts, nuts, and gaskets. The Contractor shall be responsible for adjusting the valve boxes to the proper length to conform with the ground surface.

3.02 BLOCKING UNDER GATE VALVE

A. Gate valves 18 inches and larger which are buried shall rest on a concrete pad. Pad shall extend for the full width of the trench and from back of hub to back of hub (or flange). Care

shall be taken to not interfere with the jointing. Concrete shall be minimum 1500-psi compressive strength.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of the equipment, an acceptance test to verify the satisfactory operation of each unit shall be conducted. The test shall be conducted in a manner approved by and in the presence of the Engineer. The unit shall be checked for general operation and leakage. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

3.04 SCHEDULE

A. The required valves and certain pertinent data is given below. This list is given to facilitate description of the various valves and as an aid to plan take off and is not guaranteed to be complete.

Item No.	Service	Number Required	Size and Ends	Operator Type
1	Raw Water	4	24” Flanged	Manual

END OF SECTION

40 05 64 BUTTERFLY VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install butterfly valves.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. DeZurik.
2. M&H.
3. CMB/K-Flo.
4. Pratt.

B. Acceptable Motor Actuator Manufacturers:

1. AUMA,
2. EIM,
3. Limitorque
4. Rotork.

C. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing tight-closing, rubber-seated butterfly valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 years' experience in the manufacture of valves.

D. Manufacturer's Representative for Startup and Testing: The Valve Vendor or Manufacturer shall provide the services of a competent manufacturer's representative for an indefinite period of time as required to insure proper adjustment, installation, and operation of the valve.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Shop Drawings (needed if electric actuators are used).
2. Operation and Maintenance Manuals.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Fittings

2. American Society for Testing and Materials (ASTM) Standards:

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Standard Specifications for Stainless Steel Bars
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM B148	Standard Specifications for Aluminum Bronze Coatings

3. American Water Works Association (AWWA) Standards:

AWWA C504	Standard for Rubber-seated Butterfly Valves
AWWA C550	Standard for Protective Interior Coatings for Valves and Hydrants

2.00 PRODUCTS

2.01 VALVE CONSTRUCTION

A. General: Butterfly valves supplied under this Contract shall be of the tight-closing, rubber seated type with rubber seats that are securely attached to the valve disc or body. Valves shall be bubble tight at rated pressures with flow in either direction and shall be satisfactory for applications involving valve operation after long periods of inactivity. Butterfly valves shall conform to the applicable requirements of AWWA C504 and AWWA C550. All valves for potable water service shall comply with NSF61 standards.

B. Valve Bodies: Valve bodies shall be constructed of cast iron ASTM A126, Class B or ASTM A48, Class 40 or ductile iron in accordance with ASTM A536, Grade 65/45/12. Valve class shall be suitable for the pressure class of the adjacent pipe in which it is installed**.** Valve Bodies shall be of the wafer body style and shall be suitable for use between ANSI B16.1 Class 125 cast iron flanges.

C. Valve Discs: Valve discs shall be cast iron conforming to ASTM A126, Class B, aluminum bronze conforming to ASTM B148, or ductile iron conforming to ASTM A536, Grade 65/45/12.

D. Valve Shafts: Valve shafts shall be turned, ground and polished, constructed of stainless steel conforming to ASTM A276. Valve shafts may consist of a one-piece unit extending completely through the valve disc, or may be of the “stub shaft” type, which comprises two separate shafts inserted into the valve disc hubs. If of the “stub shaft” construction, each stub shaft shall be inserted into the valve disc hubs for a distance of at least 1-1/2 shaft diameters. The shaft shall be tightly connected to the disc using tapered or wedged keying devices.

E. Valve Seats: Valves shall have Neoprene, Buna-N or other synthetic rubber resilient seas to provide tight shut off at the pressure specified. The mating seat surface shall be ASTM A276, 18-8 stainless steel or a 95 percent pure nickel overlay. All valves shall have replaceable, adjustable seats. Valves 30 inches and larger shall have in-line replaceable seats.

F. Valve Bearings: Valve shall be fitted with sleeve type bearings. Bearings shall be of corrosion-resistant and "self-lubricated" materials that will not deteriorate natural or synthetic rubber.

G. Valve Shaft Seals: Where shafts project through the valve bodies for operator connection, a split-V or O-ring type shaft seal shall be provided.

2.02 VALVE OPERATORS:

A. General: The valve operator shall be designed and manufactured in accordance with the applicable requirements of AWWA C504 and AWWA C540, and shall be arranged for horizontal or vertical valve shaft installation.

B. Manual Operators:

1. Manual operators shall have all gearing totally enclosed and shall be pre-lubricated or grease packed. Operators shall be of the worm gear or travelling nut and link type with field adjustable stops to prevent over travel in the open or closed positions. The direction of the manual rotation shall be clockwise to close.

2. Operators for exposed valves shall be provided with a valve position indicator and a handwheel or chain and sprocket device. Provide chain and sprocket for valves greater than 6 feet above walking surface.

3. Operators for buried valves shall have an extended stem with a 2-inch square operating nut within 12 inches of the finished grade. Provide a cast iron valve box to enclose the operating stem. Valve box shall be three-piece extension type equal to Mueller No. 10380 or Clow F2450. For valves which are installed with the shaft vertical, provide a level gear for vertical operation of the operating nut.

2.03 ELECTRIC MOTOR OPERATORS

A. General:

1. The valve operators shall be of the reversible motor type. The rate torque capacity of each operator shall be sufficient to seat, unseat, and rigidly hold in any position the valve disc that is controlled under the operating conditions.

2. Operators shall be self-contained units comprising housing, motor reversing contactor, limit switches, torque switches, relays, control transformer, gear train and auxiliary handwheel.

3. Operator shall move the valve from fully open to fully closed position, or from fully closed to fully open, in approximately 60 seconds. Time of travel shall be based on a geared reducer, not jogging the motor.

B. Construction:

1. Operators shall be equipped with an auxiliary handwheel to provide for actuation of the valve in the event of a power failure. The handwheel shall have a clutch so that it will not turn during normal operation of the valve. The clutch shall lockout the motor so that it will not engage when the wheel is turning.

2. Each operator shall have an integral three-phase, full voltage, reversing contactor with electrical and mechanical interlocks and three over-load sensing relays. The contactor

shall operate on 120 VAC and shall have a control transformer 460 VAC to 120 VAC. The control transformer shall be sized with sufficient capacity to operate the contactor and the motor switch compartment heaters.

3. Limit switches shall be furnished for the end of stroke disconnect, other control functions, and remote and local Open and Closed indications. Limit switches shall be independently adjustable at the open and close limits. Auxiliary limit switches for remote Open and Closed indication shall have isolated Form C contacts rated at 120 VAC.

4. The operator enclosure shall be NEMA 4X. Space heaters with thermostat shall be provided in the enclosure of wattage suitable for keeping the compartment dry at all times. There shall be installed also a suitable breather and drain. A laminated schematic wiring diagram shall be attached and protected from the environment for maintenance use. A terminal strip shall be provided in the switch compartment. Controls and switch compartments shall be shop wired to terminal strip complete and ready for field installation. All wires to terminal strip shall be identified.

5. Motor shall be for 460, 3-phase, 60-Hertz service, and control voltage shall be 120 VAC provide by an internal transformer. Motor shall be designed for continuous use**.**

6. Valves shall have Local-Remote selector switch, Open/Stop/Close Pushbuttons and Open and Closed indicator lights mounted on the operator. Selector switches and pushbuttons shall be provided with water-tight boots.

7. Non-modulating valves shall receive an open signal and a closed signal from remote, and shall provide contacts for REMOTE STATUS, OPENED, CLOSED, HIGH TORQUE.

3.00 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the Manufacturer's instructions. Valve shaft shall be truly vertical or horizontal as indicated.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of the butterfly valves an acceptance test shall be conducted to verify the satisfactory operation of the valves. The valves must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

3.03 SCHEDULES; VALVES

A. The required valves and certain pertinent data is given below. This list is given to facilitate description of the various valves and as an aid to plan take off and is not guaranteed to be complete.

Item No.	Service	Number Required	Size and Ends	AWWA Class	Max. Diff. (psi)	Type Operator
1	Raw Water	4	24" Flanged	150B	35	Electric

END OF SECTION

40 05 65.29 DUAL DISC CHECK VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install dual disc, wafer type check valves at the locations indicated.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings.
2. Certificate of Adequacy of Design.
3. Operation and Maintenance Manual.
4. Certified Test Reports.

1.03 QUALITY ASSURANCE

A. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing dual-disc swing-check valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 years of experience in the manufacture of these valves.

B. Factory Testing: The valves shall be hydrostatically tested at twice their rated working pressure. A seat closure test at the valve rating shall be conducted to demonstrate zero leakage. Additional tests shall be conducted per AWWA standards. The Manufacturer shall provide certified test reports.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ANSI B16.1	Cast Iron Pipe Flanges and Fittings
AWWA C518-08	Dual-Disc Swing-Check Valves for Waterworks Service

2.00 PRODUCTS

2.01 DUAL DISC CHECK VALVES

A. Check valves shall be of the wafer type and shall be dual disc type with vertical pivot pin and spring action closing to assure non-slam closing. Valves shall be manufactured for inserting between standard ANSI Class 125 pipe flanges.

B. Body shall be cast iron; discs shall be stainless steel; seal shall be EPDM rubber, bonded to the disc or body. Disc pins, stop, spring retainer, and springs shall be 316 stainless steel.

C. Valves shall be installed between standard pipe flanges with gaskets and steel bolts as specified for pipe flanges. Disc pins shall be installed truly vertical.

D. Valve interior shall be coated as specified for System 1 in Section 09 96 00.01 "High-Performance Coatings."

E. Dual disc, wafer type check valves furnished shall be Crane Duo-Chek II, APCO Series 9000 Double-Door Check, Tyco-Gulf Model MB, Val-Matic Series 8800, or approved equal.

3.00 EXECUTION

3.01 INSTALLATION

A. Installation and adjustment shall be made in accordance with instructions which shall be furnished by the Vendor or Manufacturer. Construction Contractor shall furnish flange nuts, bolts, washers, and gaskets for all valves.

B. Carefully handle and lower the valves into position so to prevent damage to any part of the valves.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of the valves an acceptance test shall be conducted to verify the satisfactory operation of the valves. The valves must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

3.03 VALVE SCHEDULE

A. Valves required under this Section are tabulated below:

Number Required	Size	Ends	Pump Shutoff Head	Pressure Class	Max. Diff. at Pump Start*	Max. Diff. Pressure at Power Failure**	Operating Flow
4	24"	Flange	47 PSI	150 PSI	32 PSI	15 PSI	7.5-15 MGD
* Pump Shutoff head minus static pressure ** Static Pressure							

END OF SECTION

40 05 78 AIR RELEASE AND AIR AND VACUUM VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install air release and air and vacuum valves of the sizes and types indicated. Furnish the necessary isolating valves and piping.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings.

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

A. General:

1. Each air valve shall have a cast iron body, bronze, or stainless steel trim and stainless steel float. Float shall be baffled to prevent air from blowing valve closed until air is exhausted.

2. Valve body, float, etc., shall be designed for a working pressure and shall seat at a minimum pressure shown in the valve schedule, Paragraph 3.02.

3. Air valves shall be manufactured by the Valve and Primer Corporation (APCO), Val-Matic Manufacturing Corp., or Multiplex Manufacturing Company (Crispin).

4. Top of valve assembly shall be fitted to attach discharge pipe as indicated. Valve inlet shall be N.P.T. for 2-inch and smaller valves. Valve inlet shall be ANSI flange for 3-inch and larger valves. Flange rating shall equal or exceed the maximum working pressure.

B. Air Release Valves (AR): Air release valves shall be designed to automatically release accumulated air pockets within the pipeline while in operation and under pressure. Air release valves shall be APCO Model 200, Val-Matic Model 38, or Crispin Model P.

C. Air and Vacuum Valves (AV): Air and vacuum valves shall be designed to allow large volumes of air to escape through the valve orifice when filling a pipeline and to close water tight once the air has been expelled. Air and vacuum valves shall also permit large volumes of air to enter through the valve orifice when the pipeline is being drained to break the vacuum. Air and vacuum valves shall be APCO Model 140, Val-Matic Model 100, or Crispin Model AL.

D. Combination Air Valves (CAV):

1. Combination air valves shall be heavy duty air and vacuum valves with air release.

2. Combination air valves shall be designed to release accumulations of air at high points within a pipeline by exhausting large volumes of air as the pipeline is being filled and by releasing accumulated pockets of air while the pipeline is in operation and under

pressure. Combination air valves shall also be designed to permit large volumes of air to enter the pipeline during pipeline drainage.

3. Combination air valves shall be APCO Model 140C, Val-Matic Model 200, or Crispin Model C.

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and install valves vertically in such a manner as to prevent damage to any part of the valves. Installation shall be in accordance with the Manufacturer's instructions. Provide nuts, bolts, and gaskets where applicable.

3.02 SCHEDULES

A. Valve Schedule:

No. Req.	Location	Size	Type	Working Pressure	Min. Pressure
1	All P.L. High Points (at pump station discharge header)	8"	CAV	35 psi	10 psi
2	All P.L. High Points (at meter run)	4"	CAV	35 psi	10 psi
4	Pump Discharge	4"	CAV	35 psi	15 psi

END OF SECTION

40 90 00 INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

1.00 GENERAL

1.01 SCOPE

A. General Requirements for Instrumentation and Control.

1. There are two areas of work in the Instrumentation Work in this project as described below:

a. The Instrumentation System Integrator Contractor shall provide all hardware, software, and configuration and integration associated with the PLC based Instrumentation and Process Control system. Provide a complete and operational system in accordance with these Contract Documents:

1). Provide instrumentation, hardware, conductors and raceway required for a complete and operable system that is above that specified in the Contract Documents. Provide all labor and materials specified in the Contract Documents.

b. Provide all required labor, materials and PLC programming and system configuration and integration to interconnect the I/O as required per the project to the RTU at the Robinson Rd Pump Station.

1). Provide all required software and programming in each of the PLCs and existing computer system for a complete and operational system in accordance with these Contract Documents.

2). Coordinate and fully cooperate with the Owner to provide all required hardware and PLC hardware and PLC programming necessary to interface with the existing system.

3). Provide personnel to check out, test and commission the system.

4). Provide factory trained personnel to train the Owner's staff as specified.

5). Provide software programming to create new screens and modify existing screens on the existing computer system as specified.

6). Provide the required drivers, if required, to receive and transmit data over the licensed frequency radio system to fully communicate with the PLC systems.

1.02 QUALITY ASSURANCE

A. GENERAL: Should there be a conflict between various standards, codes, specifications, and contract drawings, bring the matter immediately to the attention of the Owner's Representative.

B. REFERENCE STANDARDS:

1. American Society of Testing Materials:

A269	Seamless and Welded Austenitic Stainless-Steel Tubing for General Service
B 68	Seamless Copper Tube
D 1047	Polyvinyl Chloride Jacket for Wire and Cable
A 36	Specification for Structural Steel
	Zinc Coating (Hot-Dip) on Iron and Steel Hardware

2. Research Council on Riveted and Bolted Structural Joints (RCRBSJ).

3. American Institute of Steel Construction (AISC).

4. Steel Structures Painting Council (SSPC): Painting Specifications for weather exposure.

5. American Welding Society (AWS): Welding Code D 1.1-75.

6. Federal Specifications: Primer, Paint Zinc, Chromate, Alkyd Type, Fed. Spec. TT-P-645a.

7. National Electrical Manufacturers Association (NEMA).

8. National Fire Protection Association (NFPA): National Electrical Code (NEC), 1990 edition.

9. Instrument Society of America (ISA):

RP 3.1-1960	Flow Meter Installations, Seal and Condensate Chambers
S5.1-1973	Instrumentation Symbols and Identification
RP7.1-1956	Pneumatic Control Circuit Pressure Test
S7.3-1975	Quality Standard for Instrument Air
RP18.1-1965	Specifications and Guides for the Use of General-Purpose Annunciators

S5.4-1976	Instrument Loop Diagrams
S8.1-1968	Instrument Enclosures for Industrial Environments
RP12.1-1960	Electrical Instruments in Hazardous Atmospheres
RP20.1, 20.2	Specification Forms for Instruments
S39.1-1972	Control Valve Sizing Equations
S39.2-1972	Control Valve Capacity Test Procedures
S51.1	Process Instrumentation Terminology

10. American Petroleum Institute (API):

API RP 550	Manual on Installation of Refinery Instruments and Control Systems
API RP 520	Recommended Practice for the Design and Installation of Pressure-Relieving Systems in Refineries

11. Scientific Apparatus Makers Association (SAMA):

PM 20.1-1973	Process Measurement and Control Terminology
RC5-10-1963	Resistance Thermometers

12. Underwriters' Laboratory (UL): Subject 13, Subject 1227.
13. Factory Mutual (FM).
14. American National Standard Institute (ANSI):
15. Supplement to C37.90-1971, Relays and Relay Systems Associated with Electric Power Apparatus (IEEE Std. 313-1971), C37.90a-1974.
16. National Bureau of Standards (NBS).
17. Institute of Electrical and Electronics Engineers (IEEE): Tray Fire Tests, IEEE 383.

1.03 GUARANTEE

A. GUARANTEE PERIOD: The Contractor shall provide guarantees as defined hereunder for a period of one year after final acceptance by the Owner.

B. GUARANTEE REQUIREMENTS FOR ANALOG DEVICES: Each device shall perform its intended function within the specified operating accuracy and repeatability without more than 12 adjustments for any consecutive period of 12 months. The availability of each device shall be not less than 98.0 percent for any consecutive period of six months. Downtime of analog devices affecting more than 8 loops shall be considered a system failure.

C. CONTRACTOR'S QUALIFICATIONS

D. The Instrumentation System Integrator Contractor's personnel shall have a minimum of ten years of prior experience in furnishing, installation, testing, programming, debugging, start-up, and training for systems at least as large and similar to the one in this Contract. The system installer shall have employees who are qualified technicians for the duration of the contract located in the project area. The Contractor shall submit for evaluation within one week of Notice to Proceed, his instrumentation systems installer's company resumes complete with company history, project lists, locations, Owner, costs, type of system installed, and references with phone numbers. Installers not meeting these qualifications shall not be accepted. As a part of this contract, the instrumentation system installers shall assume complete system responsibility, including coordination and interfacing with all subsystems and equipment suppliers and manufacturers. The Contractor shall actively be involved in control system integration industry for the last five years. The Contractor shall not act as a broker for the project; he shall provide and be responsible for all hardware, interfacing software, training, testing, and extended warranties.

1.04 DEFINITIONS

A. The terms used in this specification conform to definitions in ISA S51.1, SAMA PMC 20.1-1973 and RC 5-10-1963, except as modified below.

1. Device: An electronic or mechanical apparatus designed to perform a specific measurement or control function.

2. Equipment: The machinery used in a process, e.g., pumps, fans, etc.

3. Interchangeability error: The algebraic difference between the indication and true value of the measured variable as a result of exchanging a device with a replacement.

4. Loop: Any combination of interconnected transmitters, receivers, switches, alarms, indicators, controllers, computers, or final control elements.

5. Operating accuracy: Conformity of indicated value to accepted standard value or true value throughout specified operating conditions with a confidence level of 95 percent includes, but is not limited to, hysteresis, linearity, and operating influence of temperature, pressure, supply voltage, and transmitter power supply. Operating accuracy for loop is defined as root-mean-square (RMS) of individual device operation accuracies.

6. Process: A progressively continuing operation that consists of a series of controlled actions systemically directed toward a particular result, e.g., a process to mix, filter, heat, and/or cool air to a particular condition.

7. Response: The results of the act, or process of measuring the time difference between the time of a change in an input signal or a measured variable, and the time when the output, display, and final control element in the loop has changed to at least 60 percent of the change which should result from the input change.

8. Subsystem: A discrete subdivision of a system and an assemblage of parts, devices, or software modules designed to perform one or more of the specific tasks required for the system to accomplish its functions.

9. System: An assemblage of sometimes diverse parts, devices, or software modules serving a common set of measurement or control functions.

10. Time resolution: The result of the act or process of rendering distinguishable events occurring at nearly the same time. Expressed as a measurement of time in seconds.

11. Unit: Any combination of equipment items interconnected in a predetermined manner, performing one or more controlled actions toward a particular result. A discrete subdivision of a process.

12. Concealed - Accessible: Out of general sight, but can be easily reached by removing panels or access doors.

13. Concealed - Inaccessible: Out of general sight and cannot be easily reached except by removing a permanent part of the building or using special tools.

14. Exposed: Open to general view without removing panels, access doors, or a permanent part of the building.

15. Field termination point: Termination of a run of raceway from an instrument panel to the vicinity of a field instrument. Field termination point is usually within five horizontal feet from the field instrument.

16. Analog device: Any sensor, transmitter, indicator, recorder, controller, computing relay, or control valve which transmits or receives an analog signal. Excludes the analog portion of a digital system or I/O subsystems.

1.05 SUBMITTALS

A. SHOP DRAWINGS AND PRODUCT DATA:

1. Submittals shall be in accordance with Section 01 33 00, “Document Management”.

2. Detail: Give sufficient detail to permit system configuration, installation, and wiring without reference to design drawings. Refer to Division 1 - General Requirements.

3. As a minimum, shop drawings shall include a bill of materials with original manufacturer's name and catalog number (re-labeled component information is not acceptable), original manufacturer's catalog cut sheets, front views, assembly drawings, nameplate schedules, electrical schematics, and electrical connections diagrams.

4. Electrical and interconnection diagrams shall show all terminations of equipment, complete with conduit, cable, and equipment designations, and shall include terminal identification information.

5. Include size of all conduits, pipe, cables, and conductors.

6. Physical arrangement drawings shall include operating and servicing clearance requirements, cooling requirements, electrical power requirements, and cabling information.

7. Logic drawer drawings shall show used space and expansion space.

8. Show appropriate tag numbers on all product data.

9. Software specifications for all software provided in addition to existing standard software.

    a. Include fully annotated source listings, input-output requirements, memory requirements, timing and sequencing requirements, flow chart showing functions performed, operating sequences and decision points, required system configuration, list of known or anticipated limitations of software modules, list of malfunction procedures to be followed for recovering from operator error or other malfunction, and description of how each module interfaces with calling and called programs.

    b. Provide proposed screen layouts showing modifications to existing screens, and new screens: Show all displays, inputs, outputs, recorders, alarms and indications along with the associated signal tag number. Owner shall review and approve screen layouts.

B. TECHNICAL MANUALS:

1. Supply six (6) sets of technical manuals with software specifications to Owner's Representative no later than the equipment shipment date. Each set shall be bound in a standard size, three-ring, loose-leaf, vinyl plastic, hard-cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

2. Each set of technical manuals shall include a general and detailed description, a theory of operation description, detailed schematic drawings, specifications, and installation, connection, calibration, operating, troubleshooting, preventive maintenance, and overhaul instructions in complete detail with a clear and specific description of the steps the operators must take to perform each of the tasks and modes of operating specified. These manuals shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance and repair. Exploded or

other detailed views of all instruments, assemblies, and accessory components shall be included together with complete parts lists and ordering instructions. These manuals are in addition to all applicable requirements of Division 01 - General Requirements.

2.00 PRODUCTS

2.01 INFORMATION ON DRAWINGS

A. The following information is indicated on the drawings:

1. Loop diagram on flow sheet for each control loop. Diagrams are schematic in nature and intended only as a guide to work to be performed.

2. Approximate location of primary elements, instrument panels, and final control elements.

3. Location of electrical distribution panel boards for instrument electrical power.

4. Location of equipment having alarms and equipment status contacts.

5. Location of equipment being controlled by system.

B. The following information is not shown on drawings, but shall be the responsibility of the Contractor to determine, furnish, and coordinate with other divisions based upon systems specified. Show this information on project record drawings.

1. Instrument loop drawings per ISA S5.4 minimum, desired and optional items.

2. Location of electrical distribution panel boards supplying power to any device supplied under this Contract.

3. Detailed enclosure and instrument panel layouts, PLC enclosure layouts, fabrication details, and wiring diagrams.

4. Detailed system configuration.

5. Raceway and cable routing for instrumentation wiring.

2.02 OPERATING CONDITIONS

A. AMBIENT CONDITIONS: Provide equipment suitable for ambient conditions specified. Provide system elements to operate properly in the presence of radio frequency fields produced by portable RF transmitters with output of five watts operated at 24 inches from instruments in the presence of plant telephone lines, power lines, and electrical equipment, and in the presence of digital data transmission systems.

B. FIELD LOCATIONS: Field equipment may be subjected to ambient temperatures from -5 to 50°C with direct radiation and relative humidity from 45 to 95 percent with condensation.

C. POWER SUPPLY: Power supply will be 117 volts a-c, single-phase, 60-hertz commercial power. Voltage variations will be at least plus or minus 8 percent. Certain loops shall have integral power supply as specified in the Contract Documents. Power supplies shall be provided in the panels as specified in the Contract Documents or required for a complete system, plus one spare.

2.03 MATERIALS AND EQUIPMENT

A. Provide equipment of solid-state construction utilizing second source semiconductors, unless otherwise specified. Derate components to assure dependability and long-term stability. Provide printed or etched circuit boards of glass epoxy, hand or wave soldered, of sufficient thickness to prevent warping. Coat printed circuit boards in field-mounted equipment with two mils of solderable conformal coating complying with MIL-I-46058B. Alignment and adjustments shall be noncritical, stable with temperature changes or aging, and accomplished with premium grade potentiometers. Do not insert components of specially selected values into standard electronic assemblies to meet performance requirements. Use parts indicated in instruction manuals, replaceable with standard commercial components of the same description without degrading performance of completed assembly.

B. Use test equipment and instruments to simulate inputs and read outputs suitable for purpose intended and rated to an accuracy of at least five times greater than the required accuracy of device being calibrated. Such test equipment shall have accuracies traceable to the National Bureau of Standards as applicable.

2.04 SPECIAL PROJECT REQUIREMENTS

A. As a part of this Contract, the instrumentation systems Contractor shall coordinate with the Owner and with all the sub-systems suppliers and manufacturers, during bidding, construction, testing, installation and start-up phases of the project. The coordination is to assure that the instruments and sub-systems are in compliance with the Contract Documents and that the necessary tie-ins and interface signals with the existing system are provided as specified or required.

B. The instrumentation system Contractor shall provide the Owner's staff with all required training and operating procedures, at no extra cost to the Owner, in addition to the SCADA training specified in Section 40 90 02, “Supervisory Control and Data Acquisition (SCADA) System”. The training schedule shall be coordinated with the Owner's Representative. Training shall include operating, testing, calibration and programming of the system, and simple troubleshooting of the system. The training shall include manuals which are specifically written for the system provided as described in Division 1 - General Requirements of these Specifications.

C. The calibration, testing, and start-up of all the instruments whether existing or provided new, shall be done by the manufacturer's field technician/Engineer in the presence of the Owner. The Contractor shall provide a list of all manufacturers whose technicians will perform this work. The Contractor shall also provide a certified calibration report stating that each instrument shown or specified in the Contract Documents has been installed, tested and calibrated per manufacturer's recommendations and per these Contract Documents.

D. Follow-up Services: After the acceptance of the system, the Contractor shall make two (2) trips to the project site for calibration and adjustment of all the instruments and devices, including the SCADA system. The first trip shall be three months after acceptance of the complete system, and thereafter every three months for a total of four trips. These trips are in addition to all warranty items, and shall be at no extra cost to the Owner. The Contractor shall provide the services of a trained technician for each trip with appropriate calibration and testing instruments. All defects shall be immediately remedied. The trips shall be coordinated with the Owner.

E. All control software developed for this contract shall be delivered to the Owner stored on electronic media in a format suitable for installing on the existing equipment and new equipment installed under this contract. This includes all source code, complied code, link libraries, run-time libraries or other modules necessary to recreate an operational system in the event of a catastrophic failure or cessation of business by any of the Contractors. In addition, copies of all data bases and necessary associated files as configured after the final test shall be supplied on the same medium.

END OF SECTION

40 90 01 INSTRUMENTATION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to install all equipment for complete instrumentation and controls. Contractor's work shall include but not be limited to the following:

1. Installation of equipment furnished under this contract.

2. Interconnections between equipment furnished under this contract.

3. Interconnection between equipment furnished under this contract and the existing instrumentation and control equipment or that furnished and installed under other contracts.

B. The Contractor's attention is directed to the fact that instrumentation is an integrated system and as such shall be furnished by one vendor or system integrator who shall provide all the equipment and appurtenances, regardless of manufacture, and be responsible to the Contractor for satisfactory operation of the entire system.

C. Supervision, labor, tools, and materials necessary for installation of the instrumentation equipment and material furnished herein and their interconnection shall be provided by the Contractor. Installation work shall conform to applicable city, state, and national building and electrical codes.

D. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration and acceptance of the instruments.

E. Provide equipment as shown in the specifications and on the drawings.

1.02 QUALITY ASSURANCE

A. GENERAL: Equipment shall be the Manufacturer's latest and proven design. Specifications and drawings call attention to certain features, but do not purport to cover all details entering into the design of the instrumentation system. The completed system shall be compatible with the functions required and the equipment furnished by the Contractor.

B. OPERATING VOLTAGE: Electrical components of the system shall operate on 120 volt, single-phase, 60 Hertz, except as otherwise noted in the specifications.

C. POWER SUPPLIES: The drawings and specifications indicate the energy sources that will be provided. Any other devices or power supplies necessary to obtain proper operation of the instrument system from these energy sources shall be furnished with the instrumentation.

D. PROTECTION

1. The instrumentation system supplier shall be responsible for input-output isolation of all incoming and outgoing signals.

2. Each 4-20 mA DC process measurement current loop installed on this contract shall be protected by insertion of a 1/16 amp fuse, Buss Type MKB. Fuses shall be installed in standard fuse blocks.

3. The necessary fuses or switches required by the Instrumentation Manufacturer for his equipment shall be provided with the equipment. The instruments requiring an internal power supply shall have an internal ON-OFF switch.

E. INPUT/OUTPUT

1. In general and unless specifically stated otherwise, inputs and outputs involving instrumentation systems shown shall be 4-20 mA DC process measurement signals. Current loop isolators, current repeaters, or other signal isolators shall be furnished and installed as required to meet instrument specifications and to make instrumentation system fully operational.

2. Pair shielded cable, as specified in Section 26 05 19 “Low Voltage Electrical Conductors & Cables” shall be used for all 4-20 mA DC loops.

F. HARDWARE CHECKOUT

1. Contractor shall be responsible for checkout and calibration of all field instrumentation up to and including the PLC cabinets. Contractor shall provide a checkout of all I/O points under the supervision of the Owner’s Representative. Checkout shall be scheduled two weeks in advance of the date with the Owner’s Representative. Contractor shall provide a schedule of checkout and procedures to be used to the Owner’s Representative two weeks in advance of the test date for the Owner’s Representative approval.

2. I/O points and sequence of operations shall be judged Pass/Fail by the Owner’s Representative. If a point fails, the Contractor shall move on to the next point and resubmit a new test schedule to the Owner’s Representative. The Contractor shall run a rehearsal of the test procedure to be witnessed by the Owner’s Representative prior to the test date as field modifications of equipment during the testing for a failed point shall not be allowed. Testing shall simulate actual field conditions and reflect the sequence of operations expected when in use.

G. EQUIPMENT WARRANTY

1. All equipment shall be warrantied for a period of two (2) years after final acceptance.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00, “Document Management” and shall include:

1. Shop Drawings:

a. Shop drawings shall be submitted to the Engineer for approval before fabrication or shipment to the job. Equipment shall not be fabricated or shipped to the job before receipt of approved shop drawings from the Engineer.

b. Submittals for approval shall include (1) component manufacturing data sheet indicating pertinent data and identifying each component by item number and nomenclature, (2) component drawing showing dimensions, mounting, and external connection details, (3) a system piping schematic and wiring schematic each on a single drawing with full description of operation, (4) complete schematic diagram of each piece of electrical and electronic equipment including electrical valves and tolerances for each component. Component identification on the schematic shall be as described above.

c. Following approval, the manufacturer shall be responsible for preparation of the required sets of these drawings for distribution as indicated in Division 0 and Division 1 specifications.

d. Shop drawings submitted for all equipment furnished under this section of the specifications, shall be submitted at the same time in the same package. Partial submittals will not be reviewed.

B. Sales bulletins and other general publications are not acceptable as submittals for approval.

C. Equipment installation Report. Contractor shall provide an Equipment Installation Report for each instrument (flow meter, level transmitter, etc.) to the Engineer/Owner for approval. The equipment installation report shall include documentation stating that the instrument was installed and properly calibrated per the manufacturer’s recommendations by an Authorized representative of the instrument manufacturer. All parameters required for programming of the instrument shall be provided in a hard copy format as part of the equipment installation report. Documentation stating that the person performing the calibration and start-up is an authorized representative shall be provided as well.

D. Operation and Maintenance Manuals

1. Operating instructions shall incorporate a functional description of the entire system including the system schematics which reflect "as-built" modifications. Wiring diagrams shall be furnished as a part of the Operation and Maintenance Manuals which clearly show terminal numbers and wire numbers as they actually are in the instrumentation system. Instrument panel wiring shall be such that each wire installed has its own number designation at each end and such that no number is repeated. Instrument

panel wire tagging instructions as specified in Section 26 05 19, “Low Voltage Electrical Conductors & Cables” shall be followed.

2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.

3. Contractor shall provide point to point interconnection diagrams for all control/instrumentation connections between the RTU cabinet and field devices including instruments, motor starters, and switchgear. Point-to-point diagrams shall be provided for all control/instrumentation wiring between field devices and panels, i.e. motor starters, switchgear, etc. Contractor shall provide AutoCad files of interconnection diagrams to the Owner. Interconnection diagrams shall include cable no., terminal block no., instrument no., panel no., etc. Hard copies of the Interconnection drawings shall be submitted to the Engineer for approval as an official submittal prior to the final AutoCAD files being submitted.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM A-126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings

ASTM B-61 Specification for Steam and Valve Bronze Castings

1.05 JOB CONDITIONS

A. SPECIAL TOOLS: Furnish a kit which contains special size wrenches and other types of tools, not normally available, which are necessary for assembling, disassembling, aligning, and calibrating each piece of equipment. In addition, any piece of equipment (meter, test set, etc.) required by the Manufacturer to align, adjust, or otherwise calibrate any item under this section of the specification shall be furnished, including software.

2.00 PRODUCTS

2.01 REMOTE EQUIPMENT

A. Controls for remote electrically operated or motor driven equipment shall be complete, including the necessary auxiliary relays so as to require only wiring and connections to the equipment control circuit. Contacts for control of remote motor operated or electrically operated equipment shall be rated not less than 10 amperes at 120 volts unless otherwise specified herein.

B. Remote motor operated or electrically operated equipment shall have a separate 120 volt control circuit which operates through the dry contacts provided by the instrumentation system.

2.02 ENCLOSURES/PANELS

A. Enclosures and panels as indicated on the plans and in this specification shall be furnished, installed, and wired. Enclosures for equipment in the electrical room shall be NEMA 1, 14 gauge steel for interior air conditioned rooms, NEMA 12 for interior areas with ventilation and NEMA 4X, 304L Stainless Steel for all other locations. All enclosures shall have a quick release luggage type stainless steel clasp.

2.03 ELECTROMAGNETIC FLOW METER

A. Flow element shall be of the electromagnetic type utilizing the pulsed DC type Coil excitation principle with high preamp input impedance. Unit shall have zero stability feature thereby eliminating the need to stop flow to check zero alignment. Electromagnetic flow meter shall be flange mounted with remotely mounted transmitter. The flow meter body shall have an internal diameter not less than the line size indicated and be constructed of 316 stainless steel with AWWA Class D flanged ends of epoxy coated carbon steel. The flow tube shall be rated IP68 for indefinite submersion. The flow meter shall be provided with an NSF 61 drinking water approved hard rubber liner and shall include two 316 SS measuring electrodes. Two additional electrodes for grounding and empty pipe detection shall be of the same material Electrodes shall be either flush or bullet nose type. Suitable covers shall be provided for flow elements ends to protect the tube liner during shipment. Install grounding rings on the flow tube.

B. The flow meter shall generate a HART 4-20mA and pulse output linearly proportional to flow for full-scale velocity settings from 1 to 33 feet per second. Accuracy of the flow meter shall be ± 0.2% of rate ± 0.01% of full scale (33 ft/sec).

C. The meter shall incorporate a high impedance amplifier of 1012 ohms or greater, eliminating the need for electrode cleaning systems. The meter shall utilize bipolar pulsed DC coil excitation with auto-integrated zeroing each half-cycle. Manual zero adjustment shall not be required. Power consumption shall be no more than 15 VA, independent of meter size. Meter shall operate via external 120VAC source.

D. The magnetic flow meter shall be microprocessor based with remote mounted electronics. The electronics enclosure is to have a NEMA 4X rating. Flow transmitter shall be enclosed and indicating & suitable for mounting with the flow element. Output span and zero shall be manually adjustable.

E. The meter's analog and pulse outputs shall be independently selected by push buttons. The analog output shall be an isolated 4-20 mA DC into 700 ohms load. The pulse output shall be an open collector output with a maximum frequency of 1000 Hz with configurable pulse width (0.05 to 2 sec). An open collector status output shall indicate either system or process error, or flow direction. An auxiliary input shall be available for positive zero return. A low flow cutoff will be standard, which can be turned on or off by push buttons.

F. A 4-line, 16-digit LCD backlit display shall indicate flow rate and/or total flow. The totalizer value shall be protected by EEPROM during power outages. The display shall also be capable

of indicating error messages such as empty pipe condition, error condition, and low flow cutoff. The flow meter shall have the capability of being programmed remotely using HART protocol.

G. Electromagnetic flowmeter shall be Siemens Sitrans FM Mag 5100W flanged meter, Rosemount 8700 Series, or Endress & Hauser Promag W500 no approved equal.

H. Electromagnetic flowmeter shall be provided with 1 year manufacturer's warranty.

I. Calibrations, programming and startup of flow meter in the field shall be performed by the instrument manufacturer's factory technicians only. Flow meter will not be accepted without factory technician starting up, programming, and calibrating flow meter. No exceptions.

J. Contractor shall field verify size of piping for installation of flow meter. Provide letter as a formal submittal to the Engineer that the line size required has been field verified and the gallons per minute for the application has been coordinated with the motor manufacturers.

Tag	Service	Range
FE/FIT-250	Discharge Flow	0 to 35,000 gpm (0 to 50 MGD)

2.04 SUBMERSIBLE LEVEL TRANSMITTER

A. The submersible level transmitter shall be a two-wire device that provides a 4-20 mADC output proportional to level an shall be powered by 24 VDC.

B. The level transmitter shall consist of a submersible bonded strain gauge pressure-sensing element, encased in a watertight case with 316 stainless steel wetted materials. The unit shall be designed for severe service/high solids environment with turbulence and have a 316 SS cage with welded end cap and ½" NPT conduit connection. The unit shall have NEMA 6P, IP 68 environmental protection rating. It shall be supplied with standard polyurethane shielded and vented cable, with enough cable to meet the application per the plans. Unit shall be supplied with a lifting ring to support the pressure transducer with stainless steel cable.

C. The cable can be connected directly to the signal input terminals on the main control panel without intervening junction box or calibration device required. The device shall require a 10-30 VDC low voltage power supply. The output shall be a standard 4-20mADC control signal, factory set proportional to the selected fixed range of the transducer, and shall have an accuracy of 0.25% of full scale (including the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors). Repeatability shall 0.5% of full scale or better. The units shall have a three (3) year warranty from date of shipment.

D. The level transmitter shall be a Noshok Model 613 Series Cage Protected Submersible Level Transducer or pre-approved equal by addendum.

E. Submersible transducers used in Hazardous Locations with Class I, Div.2 ratings shall be classified for the environment.

F. Manufacturer shall provide a desiccant filter to the atmospheric tube. Attachment shall be replaceable in the field.

Instrument Tag	Service	Range
LPE-101	Wet Well	40 ft

2.05 LEVEL SWITCH

A. Level detecting device shall be a 5 ½" diameter type 316 stainless steel float switch with a mercury free switch inside and flexibly supported by a PVC jacketed, heavy-duty cable. The float shall be cable suspension mounted with a stainless steel weight where applicable.

B. Float switch shall have a 1 amp rating at 150 VAC. The float shall be Type SO with four #16 AWG fine-stranded copper conductors. Float shall be mounted using stainless steel suspension cable with a stainless steel weight. Float switch shall be Contegra Model FS 90 or approved equal.

C. Float switch shall be installed in accordance with the manufacturer's recommendations.

D. Coordinate elevations with the Owner prior to submittals.

Instrument Tag	Service	Setpoint
LSLL-101	Wet Well	6'-0" AFF

2.06 PROCESS INDICATORS

A. Process indicator shall take a 4-20 mA DC process variable signal input and display the current value of the process variable in engineering units on a 4-1/2 digit display. Display digits shall be bright red .56" seven segment light emitting diodes (LED's). Accuracy of unit shall be ±1% and each unit shall have a loop power supply for powering its own loop. Decimal point shall be movable by internal switches unit shall be powered by 120 VAC.

B. Level Indicating Transmitter: The level indicating transmitter "LIT-1" at the level relay panel "LRP-01" shall be a process indicator that meets the requirements of this section and capable of retransmitting the 4-20mA signal as an analog output. The indicating transmitter shall be mounted to the front door of the level relay panel and labeled.

C. Process indicator shall be Red Lion, Precision Digital PD 620 or pre-approved equal by addendum.

2.07 PRESSURE TRANSMITTER

A. Gauge Pressure transmitter shall be of the capacitance type with a process isolated diaphragm with silicone oil fill, microprocessor based "smart" electronics, and a field adjustable rangeablility of 20:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being

disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.100 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4 20 mA, 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4 digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required.

B. Transmitter shall be a Rosemount Model 2088 or pre-approved equal by addendum. Transmitter shall be supplied with a 316 Stainless Steel Block and Bleed Valve, Rosemount, or pre-approved equal by addendum.

Instrument Tag	Service	Range
PIT-201	RWP-201 Discharge	0-150 PSI
PIT-202	RWP-202 Discharge	0-150 PSI
PIT-203	RWP-203 Discharge	0-150 PSI
PIT-204	RWP-204 Discharge	0-150 PSI

2.08 INTRUSION ALARM

A. Hermetically sealed brushed anodized aluminum housing, Rhodium plated switch contacts, industrial wide gap magnetic contacts, UL listed, surface mount, 3' stainless steel armored cable, Sentrol 2500 series. Provide with one normally open and one normally closed set of contacts.

Instrument Tag	Service
XS-311	Electrical Building Double Door
XS-312	Electrical Building Single Door

3.00 EXECUTION

3.01 INSTALLATION

A. Wire each device requiring power so that when wires are removed from any one device, power is not be disrupted to any other device. Ground the case of each device either by mounting directly on a steel frame or by a third wire.

3.02 FIELD QUALITY CONTROL

A. The supervisory service of a factory-trained service engineer who is specifically trained on the type of equipment herein specified shall be provided during construction to assist the Contractor in the location of sleeves; methods of installing conduit and special cable; mounting, piping, and wiring one of each type of device, and the methods of protecting all of the equipment prior to placing it into service. Upon completion of the installation, the services of the above service engineer shall be provided for calibration and start up of the

equipment and for instructing the operating personnel. The Manufacturer shall provide sufficient service to place the system in satisfactory operation.

B. Check out and calibrate the system upon completion of the installation.

C. Prior to the Owner turning on any form of energy to the system, the Contractor shall provide the Engineer with a certified statement of approval of the installation including his supplier's authorization for turning on energy to the system.

END OF SECTION

40 90 02 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

1.00 GENERAL

1.01 SCOPE

A. This section specifies furnishing, installing, testing, and start-up operations of a complete control sub-system as indicated in the Plans and as specified herein. The system shall be totally integrated with the existing SCADA system. The system shall be configured to operate as a Distributed Control System having an open system architecture.

B. The SCADA System Integrator Contractor shall provide all hardware, software, and configuration and integration associated with the Remote I/O based Instrumentation and Process Control system at the elevated storage tank. Provide a complete and operational system in accordance with these Contract Documents:

1. Provide instrumentation, hardware, conductors and raceway required for a complete and operable system that is above that specified in the Contract Documents. Provide all labor and materials specified in the Contract Documents.

    a. RWPS Electrical Building:

        1). Provide one (1) PLC. The PLC shall be located in a RTU cabinet at the site.

        2). Provide all required labor, materials and PLC programming and system configuration and integration to interconnect the new PLC via cellular radio to the existing Pine Street Water Treatment Plant PLC and SCADA system at the computer system at the Owner's main control room.

2. Modify existing PLCs at the Owner's main site as required.

3. Provide all required software and programming in the PLCs and existing computer system for a complete and operational system in accordance with these Contract Documents.

4. Coordinate and fully cooperate with the Owner to provide all required hardware and PLC hardware and PLC programming necessary to interface with the existing system.

5. Provide personnel to check out, test and commission the system.

6. Provide personnel to train the Owner's staff as specified.

7. Provide software programming to create new screens and modify existing screens on the existing computer system as specified.

C. System Components: The system will consist of the following major components and subsystems:

1. Pump Station:

a. One (1) PLC CompactLogix with Expansion Pack. The PLC shall be located in a NEMA 4X 316 stainless steel enclosure.

1). One (1) Uninterruptible Power Supply (UPS)

2). One (1) Manage Industrial Ethernet Switch

3). One (1) Touch screen

4). One (1) Cellular radio

2. Software

3. Spare Parts

D. Software Requirements - The SCADA System Integrator Contractor shall work with Owner, to provide as a minimum the following software modifications:

1. Program the PLC(s) provided under this section. PLC shall be programmed using manufacturer's recommended software. A copy of all programming shall be provided to the Owner.

2. Program the graphic user interface touchscreens at the Pump Station RTU Panel.

E. Onsite Requirements - The SCADA System Integrator Contractor shall have technical staff on site as required to provide a complete and operating system and shall include as a minimum:

1. Preliminary Site Visit – Two (2) days.

2. Programming System Upgrades – One (1) week.

3. Testing/Startup Site Visit – One (1) week.

F. Reference Standards:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

a. C37.90.1, IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.

b. C37.90.2, Trial Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

c. Electronic Industries Association (EIA):

d. RS-232-C, Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.

e. RS-422-A, Electrical Characteristics of Balanced Voltage Digital Interface Circuits.

2. National Electrical Manufacturers Association (NEMA):

   a. ICS 1, General Standards for Industrial Control and Systems.

   b. ICS 1.1, Safety Guidelines for the Application, Installation and Maintenance of Solid State Control.

   c. ICS 4, Terminal Blocks for Industrial Use.

   d. ICS 6, Enclosures for Industrial Controls and Systems.

   e. Publication No. 250, Enclosures for Electrical Equipment (1000 V maximum).

3. National Electrical Code.

4. ISA Standards

5. IEC 2 KV Isolation test

6. IEEE472/ANSI C37-90A Surge withstand capability test.

7. IEEE 802.3

G. Lightning/Surge Protection

1. Lightning/Surge protection shall be provided to protect the Supervisory Control & Data Acquisition system from induced surges propagating along the communications, signal and power supply lines. The protection systems shall not interfere with normal operation, but shall be lower than the surge withstand level for the device they are protecting and be maintenance free and self-restoring.

2. All wiring, hardware, and connections means shall comply with the National Electrical Code and/or applicable local codes.

3. Lightning/Surge protection devices shall be mounted as close to the equipment they are protection as possible. Mounting guidelines will be followed as indicated in installation instructions provided by the manufacturer. Wires shall be attached by means of a cable-clamping terminal block activated by a screw. Connections shall be gas-tight, and the terminal block shall be fabricated on non-ferrous, non-corrosive materials. All wiring points and plug connections shall be “touch safe” with no live voltages that can make contact with a misplaced finger.

4. Panel mounted Lightning/Surge protection devices shall consist of two parts; a base terminal block and a plug protection module. Base shall directly connect to DIN rail. Replacing a plug shall not require the removal of any wires nor shall it interrupt the signal. Base and plug shall have the ability to be coded to accept only the correct voltage plug. Field mounted Lightning/Surge protection devices shall be contained in NEMA 4X housings.

1.02 SUBMITTAL

Submittals shall conform to the requirements set forth in section 01 33 00, "Document Management". Submittals for 40 90 02, "Supervisory Control and Data Acquisition (SCADA) System" shall not be combined with any other submittals. Submittals shall be organized by site, and each sheet shall be labeled with the site name. Each site shall have a notebook divider with its name clearly printed.

A. Loop diagrams shall be prepared according to ISA Standard ISA-S5 and using loop numbers provided.

B. Shop Drawings:

1. Component Bill of Material.

2. Data sheet clearly indicating what model and options are being provided.

3. Schematic ladder diagrams shall include all terminal blocks, hardware devices, software interlocks, software data links, and control.

4. Provide Drawings, Diagrams & Schematics shall be on 11x17 paper.

a. Control panel layout, plans, elevations (with and without doors), sections, details, etc.

b. Conduit entry and exit points clearly showing dimensions of area allowed for entry and exit points. Coordinate with the Electrical Contractor on this prior to submitting information to the Engineer.

c. Clearly indicate the vertical distance from the conduit entry point to the top/bottom of the first device mounted on the backplane.

d. A schedule defining all I/O, database reference, and point of origin or destination, and PLC system internal address.

e. I/O Drawings shall show where the signal originates from and the destination on the other side. For example, PLC input cards shall be on the right side with the field device on the left. All I/O associated with an I/O card shall be shown on the a single sheet. Each field device shall be identified by instrument tag, loop number, and instrument range (if applicable).

f. Elevation drawings shall include mounting heights of panel mounted devices including but not limited to the indication lights, switches, etc.

5. Software manuals shall be provided to configure the central system and technical review information. Provide sample program documentation from previous projects.

6. Hard Copy of software program including programs and rung comments

7. UPS Battery Sizing Calculations

C. Operation and Maintenance Manuals

1. Operating instructions shall incorporate a functional description of the entire system including the system schematics which reflect "as-built" modifications. Wiring diagrams shall be furnished as a part of the Operation and Maintenance Manuals which clearly show terminal numbers and wire numbers as they actually are in the instrumentation system. Instrument panel wiring shall be such that each wire installed has its own number designation at each end and such that no number is repeated. Instrument panel wire tagging instructions as specified in Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables” shall be followed.

2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.

3. A schedule defining all I/O, database reference, and point of origin or destination.

4. Submit written description of functions, loops, and logic.

5. Submit all SAMA Logic and Wiring Diagrams and ISA Logic Diagrams for all equipment requiring programming at the PLCs, with all set points and ranges indicated.

6. Provide a hard copy of the “as-built” “as-built” wiring diagrams, panel layout, elevations, sections, details, and associated drawings in a separate binder.

7. One PDF copy and one AutoCAD (.dwg) copy of the “as-built” wiring diagrams, panel layout, elevations, sections, details, and associated drawings burned on a CD.

a. Maximum file size is 5MB. If manual is greater than maximum allowable file size, provide individual files for each major section of manual.

b. All files shall be compatible with the latest software version available.

c. Filename shall identify the plant site, plant area, equipment manufacturer, and date equipment placed in service. i.e. WWTP-PC1-Manufacturer-200503.pdf.

d. Provide a master Table of Contents which includes links to navigate to all the files on the CD. The chapter labels shall identify the information included in that chapter as well as its file name, i.e.: RTU Panel Layout.

e. Each PDF file shall 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. The chapter labels shall identify the information included in that chapter as well as its file name, i.e.: RTU Panel Layout.

f. Scanned images of written documents are not acceptable. Document must allow character selection. Text within a file shall be transferable to other documents.

g. Submit a preliminary version of the electronic format of the manual for review. Upon approval of the preliminary submittal, the Contractor shall provide 3 copies of the electronic manual to the Owner.

D. Factory Test Reports

E. Equipment Installation Report

1.03 QUALITY ASSURANCE

A. Suppliers Qualifications: The complete system shall be configured, programmed, and installed by one qualified system supplier who is regularly engaged and qualified in designing and building instrument control systems. The system suppliers shall assume complete systems responsibility, including coordination and interfacing with all subsystems and equipment suppliers and manufacturers. The installation supervisor shall have had experience in overseeing installation and start-up of at least three similar installations. The bidder shall submit, upon Engineer's request, complete company history, resumes of full time project manager for this project, other key full-time system analysts, programmers, technicians, and submit project list with costs, Owner, contact person, phone number, etc.

B. Tests: The complete system shall be assembled and tested at the job site. The Owner’s representative and the Engineer's presence will be required at the time of final testing at the system supplier's facilities.

C. Standards: All applicable NEC, ISA, IEEE, NEMA, UL, ANSI, IEC, FCC, FM standards shall apply. All equipment shall be new and UL listed and labeled.

D. Assembly, Storage, & Handling: Once assembled and tested, the system shall be stored in air-conditioned and heated rooms. Ship the unit to job site only after the control room has been built and its HVAC system is in operation.

1. The Owner may approve partial payment for SCADA equipment ready to be onsite but is stored off site. Partial payment may be disallowed by the Owner.

a. For partial payment, the Owner shall receive as a minimum a sales receipt, lien release, proof of insurance and the Owner’s name shall be stenciled on the equipment being paid for.

E. Acceptable Module Manufacturers:

1. Allen-Bradley

2. No Approved Equal

F. Acceptable SCADA Installers:

1. Champion

2. Boyer

3. No Approved Equal.

1.04 SYSTEM DESCRIPTION

A. Furnish and install a programmable controller-based supervisory control and data acquisition system configured as a distributed processing network as defined by the Contract Documents. Control functions shall include digital logic control, PID control, and setpoint control.

B. Include all hardware, firmware, software, and application programming and configuration, as necessary, to make the system completely functional and operational in accordance with the Contract Documents. All necessary components and equipment which are not specifically described in the Contract Documents, but which are necessary to configure an operational distributed control system as described herein, shall be identified, furnished, and installed by the CONTRACTOR. The system provided shall be the vendor's standard; a prototype system will not be accepted.

C. The Remote I/O Module along with all associated equipment shall be housed in its own separate cabinet. This includes mounting the UPS in the PLC cabinet.

D. Contractor shall coordinate with Owner for information to be read over Ethernet and RS485 data highways.

1.05 SPARE PARTS, TOOLS, AND SUPPLIES

A. As a minimum, provide the following compatible spare parts, tools, and supplies as a part of this CONTRACT:

1. Two (2) each I/O modules for analog and discrete input/output signals. Each module to have 8 I/O points for analog, 16 I/O points for discrete.

2. Two (2) pushbuttons and two (2) pilot lights of each type furnished.

3. In addition to above, provide the manufacturer's recommended spare parts for each piece of equipment furnished.

4. One (1) spare PLC CPU of each type furnished.

5. Two (2) spare PLC power supplies and I/O cards of each type furnished.

6. Two (2) spare 24 V. DC power supplies of the type furnished.

7. One (1) spare UPS unit of each size furnished.

1.06 WARRANTY

A. The Equipment supplier and the CONTRACTOR shall warrant to the Owner that the equipment delivered with reference to this specification complies with this specification.

B. The equipment supplier and the CONTRACTOR shall warrant the equipment as to defects in material and workmanship for a period of one year from the date of final acceptance of the project. Vendor shall include a copy of his special equipment warranty with the shop drawings. The warranty specified by this specification shall be exclusive, and in lieu of all other warranties whether written, implied, orally presented, or statutory.

C. Warranty for equipment shall be through the equipment manufacturer and shall include the option to purchase additional service agreements/extended warranties after the initial warranty for up to five years.

2.00 PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS

A. PLC components at the site shall consist of the following:

1. Allen-Bradley CompactLogix with Ethernet and RS485 connections.

B. The control system shall be configured using microprocessor-based programmable controllers for local process control functions. The control system shall be equipped with power supplies and individual uninterruptible power supply (UPS) to perform logic control functions based on the program stored in memory and the status of inputs and outputs. Memory will be required such that there is a minimum of 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare capacity shall be documented by submitting to the Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available. The statement shall include an estimate of the total program and data memory necessary, including spare capacity, based on the I/O hardware for the system, and previous programming experience.

C. Control functions such as register loading, register reading, and diagnostics may be downloaded from the central computer system programming. Automatic shutdown feature shall be selectable such that the desired field condition will be the default condition in the event of power loss or system failure. Power supplies shall be provided for the process controller as required with built-in protection against short-circuits, overcurrent, and overvoltage. One communication port shall be provided for each programmable controller.

D. The programmable controller shall be capable of complete control, including PID control, digital logic control, batch, and setpoint control.

E. The entire PLC system shall immediately shut down and annunciate the occurrence of any of the following abnormal circumstances:

1. Memory parity error.

2. Loss of signal communication between CPU and I/O's.

3. Loss of logic power to any portion of the system.

4. Halt or interruption of memory scan.

5. Detection of any incomplete relay ladder rungs in memory.

F. The PLC system shall accomplish the control requirements of the loop descriptions, and Contract Documents.

G. The design application and installation of the PLC system shall conform to NEMA ICS 1.1.

H. PLC programming shall be documented annotated in detail, and factory tested.

I. Human-machine interface (HMI) at the main control room shall utilize existing system CRT displays and keyboard(s). Interface functionality shall include:

1. Indication of process variables

2. Configuration of control loop parameters

3. Adjustment of controller output

4. Display of real time and historical process trends

5. Push button station controls

6. System and process status indicators

7. Graphic representation of plant operations with interactive status and measurement symbols

8. Annunciation

J. The PLC system shall operate in ambient conditions of 32 to 140F temperature and 0 to 95 percent relative humidity without the need for purging or air conditioning.

K. Utilize a power turn-on time delay circuit when powering up or down DC power supplies to ensure power supply output voltage has reached the proper value prior to application of power to solid state logic and output circuits. PLC shall report a loss of power and operation from UPS to the Operators Work Station at the main control room.

L. Environmental Controls:

1. Furnish circulation fans in solid state control system enclosures.

2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.

3. Air conditioning applications shall include means of preventing moisture condensation.

M. Input/Output Connection Requirements:

1. Outputs shall be fused:

a. External fusing shall be provided if output module does not possess internal fusing.

b. Fuses provided external to output model shall:

1). Be in accordance with module manufacturer's specifications.

2). Be installed at terminal block.

2. Install bleeding resistors across input from field devices which leak current sufficiently to flicker input status light.

3. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.

4. Prewire I/O modules to terminal blocks.

5. Provide terminal blocks with continuous marking strip.

6. Size terminals to accommodate all active data base points and spares. Terminal strips shall be provided to accommodate future I/O points associated with future equipment (motors, pressure transmitters, etc.) plus 20% spare. Provide a minimum of 20% spare I/O of all actual I/O points provided under this contract. Spare I/O shall be wired to spare terminal blocks.

7. Provide terminals for individual termination of each signal shield. Stripping back twisted shielded pair and twisting together all the shields is not acceptable.

8. Field wiring shall not be disturbed when removing or replacing an I/O module.

N. Where the PLC is utilized to control multiple trains of equipment, the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of one component does not affect equipment on all trains. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

O. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per ANSI/IEEE C37.90.2.

P. Incorporate the following minimum safety measures:

1. Master Safety Relay:

    a. Cuts off power to I/O devices upon de-energization

    b. Multiple Master Safety Relays shall be available as required to provide ability to control separate designated blocks of the control program.

2. External Watchdog Function to Monitor:

    a. Internal processor clock failure

    b. Processor memory failure

    c. Loss of communication between processor and I/O modules

    d. Processor ceases to execute logic program

3. Safety Function Wiring:

    a. Emergency shutdown switches shall not be wired into the controller.

4. An emergency power disconnect shall be placed in the power circuit feeding the power supply as a means of removing power from the entire PLC system.

    a. Capacitor shall be placed across the disconnect to protect against current outrush through trails.

5. Safe Wiring:

    a. Equipment failure mode shall be selected so that the loss of power or control signal to the equipment will result in the equipment either shutting down or operating safely.

    b. Activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.

    c. Low voltage control signal wires:

        1). Place in conduit segregated for that purpose only

        2). Twisted shielded wire pair

        Not located in the same conduit or bundle with power wiring

6. Initial Safety Conditions:

    a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.

b. Utilize program each time PLC is re-initiated and the control program activated.

7. PLC Fault Relay:

    a. Placed in series with any other emergency stop conditions

    b. Opening of PLC Fault Contact:

        1). Upon unsafe or undesirable system operation, including:

    c. Loss of memory

    d. Processor fault

    e. Power supply fault

    f. Isolation failure

    g. Communications failure

    h. Isolation failure

    i. Communications failure

    j. Scan time overrun

    k. Module failure

    l. Scan time overrun

    m. Module failure

8. Monitoring of Internal Faults and Display:

    a. Internal PLC system status and faults shall be monitored and displayed. Monitored items shall include:

        1). Memory ok/loss of memory

        2). Processor ok/processor fault

        3). Battery ok/battery low

        4). Power supply ok/power supply fault

        5). Isolation failure

        6). High CPU temperature

        7). Scan time overrun

8). Module failure

9. Control of Programs:

a. Protect access to PLC program loading with locked, key operated selector switches.

10. Effects of Failure:

a. PLC system shall incorporate safe responses to the following failure effects:

1). Power losses, interruptions, excursions, dips, and transients.

2). Loss or corruption of memory

3). Information transfer corruption or loss

4). "Fail on" or "Fail off" of inputs or outputs

5). Unreadable signals

6). Addressing errors

7). Processor faults

11. Incorporate noise suppression and inductive load suppression design into input, output, and logic modules

12. Operator Intervention:

a. Logic system failure shall not preclude proper operator intervention

b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.02 COMPONENTS

A. PLC System Central Processor Unit (CPU):

1. Completely solid state CPU designed to provide:

a. Digital relay logic

b. Analog loop control

c. Other required control functions:

1). Counting

2). Floating point math computations

3). Timing

2. To provide communications with other control systems and man-machine interfaces as specified.

3. To use electrical ladder diagram style programming for discrete logic applications.

4. Memory:

   a. Battery-backed RAM

5. Memory battery backup shall be capable of 60 days memory retention with fresh battery.

   a. Provide visual indication of battery status and alarm low battery voltage.

   b. Memory battery backup shall be capable of 14 days memory retention after the "Battery Low" indicating LED is on.

6. Plug-in card design to allow quick field replacement of fault devices.

   a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.

7. 100 percent minimum spare useable memory capacity after all required programming is in place and operating.

8. Capable of executing all control functions required by the Contract Drawings including digital and analog loops.

9. Built-in three-mode (proportional-integral-derivative) control capabilities.

   a. As directly selectable algorithms requiring no user knowledge of programming languages.

10. On line reconfigurable.

11. Lighted status indicators for "RUN" and "FAILURE."

12. Capable of manual or automatic control mode transfer from the HMI system or from within the control strategy. Transfer shall be bumpless and balanceless.

B. Input/Output (I/O) Modules

1. Provide plug-in modular-type I/O racks in each PLC enclosures if required, with cables to connect to all other required PLC system components.

2. Provide I/O system with:

   a. I/O solid state boards with status lights indicating I/O status and board failure.

b. Electric isolation between logic and field device.

c. Individually fused outputs with blown fuses indication.

d. Interchangeable boards for similar I/O type to allow substitution of operating boards for failed units by the operator.

e. Capability of withstanding low energy common mode transient to 1500 V without failure.

f. Incorporate noise suppression design.

g. Capable of meeting or exceeding surge-withstand capability tests, per ANSI/IEEE C37.90.1.

h. Capable of meeting or exceeding electrical noise tests, NEMA ICS1-109.60-109.66.

i. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.

3. Discrete I/O Modules:

   a. Interface to ON/OFF devices

   b. I/O status indicator module front

   c. Voltage rating to match circuit voltage

   d. Output module current rating:

      1). Match maximum circuit current draw

      2). Minimum 1.5 A/point for 120 V AC applications

   e. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.

   f. Individually fused with blown fuse indication.

4. Analog I/O Modules:

   a. Input modules to accept signals indicated on Drawings or Specifications

   b. Minimum 12 bit resolution

   c. I/O chassis supplied power for powering connected field devices

   d. Isolated (differential) inputs and outputs

   e. User configurable for desired fault response state

f. Provide output signals as indicated on Drawings and Specifications

g. Individual D/A converter for each output module

h. Individual A/D converter for each input module

5. Spare I/O Modules: Each PLC shall have a minimum of 20 percent spare analog and 20 percent spare discrete I/O points installed and wired to terminal blocks, isolates, surge devices, and relays inside the PLC.

C. Power Supply Units:

1. Provide regulated power units:

a. Designed to operate with PLC system and shall provide power to:

1). All components of PLC system

2). Two-wire or four-wire field instruments

3). Other devices as indicated on Drawings or Specifications

4). Power supplies shall be summable type.

b. Capable of supplying PLC system when all of the specified spare capacity is utilized

c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.

2. Electrical service to PLC system is 105 to 125 V, 60 HZ, +1 percent, 1 phase power.

3. Separate AC circuit breakers shall be provided for each power supply.

4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room in the PLC system enclosure.

5. Provide integral battery backup to maintain 60 seconds upon loss of all AC power. This is required to ensure transient power surges and dips do not affect the operation of the PLC system.

6. Capable of meeting or exceeding electrical noise tests, NEMA ICS1-109.60-109.66.

7. Capable of meeting or exceeding surge-withstand capability tests per ANSI/IEEE C37.90.1.

8. Power Distribution:

a. Immune to transients and surges resultant from noisy environment.

b. Shall provide constant voltage level DC distribution to all devices.

D. Programming Software

1. The PLC shall be programmed using applicable programming software.

2. Provide a copy of all required programming software to the City. The software shall be licensed to the City, and shall be delivered to them at the end of this contract.

2.03 HMI CENTRAL CONTROL AND DATA ACQUISITION SYSTEM

A. All modifications to Grand Prairie's main HMI system at their control room shall be done by the Owner.

2.04 SURGE SUPPRESSOR

A. Surge suppressor for AC power circuits shall be UL listed or recognized. Suppressor shall be designed to withstand a maximum 10 kA test current of a 8/20 µS waveform according to ANSI/IEEE C62.41 Category C Area. Suppressor shall consist of a multistage hybrid circuit with staging inductors or resistors to properly coordinate the components. Surge protection modules shall have a visual indication of circuit integrity. Devices shall include a SPDT contact rated for at least 120 VAC, 1 Amp, for remote failure indication. AC power surge suppressor shall be Phoenix Contact Mains-Plugtrab Series or approved equal.

B. Surge suppressors for analog, discrete and data signals shall be UL listed or recognized. Suppressors shall be designed to withstand a maximum 10 kA test current of a 8/20 µS waveform according to ANSI/IEEE C62.41 Category C Area. Suppressors shall consist of a multistage hybrid circuit with staging inductors or resistors to properly coordinate the components. Analog, discrete and data signal surge suppressors shall be Phoenix Contact Plugtrab Series or approved equal.

C. Surge suppressors for field protection of analog signals shall consist of a multistage hybrid circuit utilizing only diodes and/or gas discharge tubes but no metal oxide varistors (MOV). Suppressors shall be designed to withstand a maximum 10 kA test current of a 8/20 µS waveform according to ANSI/IEEE C62.41 Category C Area. Surge protection shall not have a cutoff frequency less than 400 kHz (for a 600 Ohm system) to allow HART protocol and other superimposed smart digital signals to function. 2-wire analog field surge suppressor shall be Phoenix Contact Pipetrab Series or approved equal. 4-wire analog field surge suppressor shall be Phoenix Contact Boxtrab or approved equal.

2.05 POWER SUPPLY

A. The power supply shall be fully enclosed and provide screw terminations by means of a cable clamping terminal block activated by a screw. Connections shall be gas-tight, and the terminal block shall be fabricated of non-ferrous, non-corrosive materials. All wiring points shall be touch safe with no live voltages that can make contact with a misplaced finger. Power supply shall have integral metal mounting feet to attach to 35-mm DIN-rail.

B. The power supply shall conform to UL 508C standards allow use at the full rated current. The power supply shall have a visual indicator for applied power. Operating temperature range shall be -25°C to 70°C. Power supply shall have means of limiting DC current in case of short circuit and shall automatically reset when fault is corrected. Power supply shall be able to be run in parallel mode without external circuitry to provide redundancy. Residual ripple shall not exceed 150 mV peak to peak.

C. Power supply shall be Phoenix Contact, Power-One or approved equal.

2.06 RTU CABINET

A. Electrical Building: Furnish and install the RTU cabinet at the location indicated. Cabinet shall be a NEMA 4X, 304 stainless steel freestanding enclosure and shall have a hinged front door with key interlocking handle. The enclosure shall be made of 14 gauge steel with a 11 gauge mounting panel inside. The enclosure shall be minimum 72”H x 60”W x 18” D. The PLC, UPS, and Central Pump Monitor Unit shall be housed in the RTU cabinet.

1. Mount the touch screen to the RTU enclosure. The touchscreen shall be mounted at a maximum elevation of 5’-0”AFF, include the housekeeping pad in the mounting height.

2. Incoming/outgoing cables will enter through the bottom, top or side of the enclosure.

B. All discrete inputs/outputs shall have interposing relays. Interposing relays contained in this cabinet shall be 3PDT, shall have 24 VDC coils, shall each have a pilot light indicating energized coil, and shall each be mounted in a plug in socket with relay retainer clip and screw terminals. Relays shall be Square D KU13M1P14 or approved equal.

C. Instrument panel wiring shall be as follows:

1. Single conductor wire shall be stranded, tinned 16 AWG and MTW insulation, as manufactured by American Insulated Wire or approved equal. Color-coding shall be purple for ungrounded conductors and white for grounded conductors.

2. Pair shielded cable for 4-20 mA DC loops shall be as specified in 26 05 23, “Control Voltage Electrical Power Cables”.

3. Each conductor terminated under a screw head shall have a crimp on spade terminal applied to its end prior to its termination.

4. Each conductor has its own number and no number is used more than once.

5. The number of each wire is placed at both ends of the wire next to its end according to wire tagging instructions as specified in 26 05 23, “Control Voltage Electrical Power Cables”.

6. The wire numbers, as actually installed, match the numbers on the shop drawings, O&M manuals, wiring diagrams and interconnection diagrams for this instrument panel.

7. Wiring shall be run enclosed in plastic wireway wherever possible. Wireways shall be installed as required to enclose panel wiring. Where the use of plastic wireway is not practical, conductors shall be bundled and run open. Conductors run open shall be bundled and bound at regular intervals not to exceed 6" with nylon ties, or approved equal. Wires within a bundle are to be run parallel to one another and not twisted. Bundles shall have a uniform appearance, circular cross section, and shall be securely fastened to the panel framework. Conductors carrying different voltages that are from the same source may occupy the same wireway provided all are insulated for the maximum voltage of any conductor in the wireway. Wire ducts shall be insulated for the maximum voltage of any conductor in the wire duct. Wiring carrying voltages that originate at different source shall not run in the same wireway. Wire ducts shall be color coded as follows:

    a. 24VDC shall be routed in a Wire duct with a Light Grey Color cover.

    b. 48VDC shall be routed in a Wire duct with a Blue Color cover.

    c. 120VAC shall be routed in a Wire duct with a White Color cover.

    d. 480VAC shall be routed in a Wire duct with a Black Color cover.

8. Terminal blocks shall be installed for wire terminations and shall be capable of mounting on a 35mm DIN-rail. Terminal blocks shall have a method of labeling for easy identification. Typewritten labels shall denote terminal block numbers and shall match numbers shown on shop drawings, O&M manuals and wiring diagrams. 25 percent additional terminals shall be provided for Owner's use. Terminal blocks shall be available with screw clamp technology and be made of a non-corrosive material. The metal body shall contain a serrated pressure plate that will provide a gas-tight connection with the conductor. All terminal block wiring points shall be "touch safe" with no live voltages that can make contact with a misplaced finger. Terminal blocks shall be rated 600V and shall be Phoenix Contact UT Series, Allen Bradley 1492-H1 Series or approved equal.

9. A separate 120VAC Terminal Block and circuit breaker shall be provided for RTU cabinet.

D. A print pocket shall be provided in the panel and shall contain an 11" x 17" wiring diagrams, panel elevations and drawings. The wiring diagram shall contain all wire numbers, device names and terminal numbers. Drawings shall be laminated in clear plastic for preservation of the drawings.

E. Enclosure shall be provided with an enclosed switched fluorescent light and 120 volt grounded duplex receptacle. Switch for light shall be mounted on inside of cabinet, easily accessible.

F. All equipment shall be mounted in such a manner that all maintenance may be accomplished with easy access through the RTU cabinet doors.

G. Acceptable RTU cabinet manufacturers:

1. Hoffman

2. Hammond

3. Rittal

2.07 UNINTERRUPTIBLE POWER SUPPLY

A. The system supplier shall provide an Uninterruptible power supply (UPS) for the programmable controllers and its associated RTU cabinet. The systems supplier shall size the UPS for the connected load plus 100% spare capacity. UPS shall also be provided at each PLC and at each of the remote I/O locations. Utilize Gel-cell type batteries housed in their own enclosure inside the RTU cabinet. The UPS shall be Schneider Electric Panel Mounted APC DIN Rail UPS, and shall have capacity to supply power for a period not less than one hour continuously for the processing units (PLC), wireless I/O modules, 12VDC, 24VDC power supplies, and loop powered instruments connected to the PLC and I/O modules.

2.08 GIGABIT ETHERNET 3-PORT SWITCH

A. The ethernet switch shall transmit and receive 1000 Mbs data over fiber optic cable for a maximum distance of 5 miles. The unit shall utilize LED's to display POWER STATUS, TRANSMIT DATA STATUS and RECEIVE DATA STATUS. The unit shall have an operating voltage of 24VDC. The unit shall have a mean time between failures (MTBF) greater than 100,000 hours.

B. The ethernet switch shall operate in ambient conditions of 0 to 50°C temperature and 10 to 95 percent relative humidity, non-condensing.

C. The unit shall be as manufactured by Industrial Fiber Systems, Inc.

2.09 MANAGED INDUSTRIAL ETHERNET SWITCH

A. The managed industrial Ethernet Switch with gigabit-ethernet (1000 Mbit/s), a minimum of two (2) ports for single mode fiber optic fiber and a minimum of fourteen (14) ports for CAT6e cable. The unit shall utilize LED's to display POWER STATUS, LINK STATUS, DATA, and ERROR. The unit shall have an operating voltage of 24VDC and include a redundant power supply. The unit shall a mean time between failures (MTBF) greater than 200,000 hours

B. The Ethernet Switch shall operate in ambient conditions of 0 to 50°C temperature and 10 to 95 percent relative humidity, non-condensing. The switch shall be suitable for DIN-rail mounting.

C. The unit shall be an industrial managed switch as manufactured by Ruggedcom or approved equal.

2.10 PUSH BUTTON STATION

A. Rack Mounted Enclosures: NEMA 4X, manufactured from minimum 16 gauge, 316 stainless steel, with integrated mounting feet, suitable interior stiffeners, continuously welded for rigid construction, continuous piano type hinge with a door clamp assembly. All enclosures shall be single access enclosures, unless noted otherwise. Enclosures shall be finished smooth, free of all burrs, scales and imperfection, brushed smoothed. Maximum enclosure size shall be 8" x 14" x 5" (WxHxD). Enclosures shall be manufactured by Hoffman, Hammond Manufacturing, Rittal, or Saginaw Control & Engineering.

B. Mushroom Head Pushbuttons: Metal 40 or 45mm red color head, two-position maintained push-pull type, twist-to-release, with silver alloy contacts rated for 10 A continuous current.

C. Nameplates: Enclosures and exterior mounted enclosure components will be supplied with unique nameplates. Each device nameplate shall describe the field device and the function it serves. Nameplates shall be phenolic (Lamicoid), with a minimum 1-inch tall, engraved letters, with fixed to panel with epoxy adhesive. Nameplates for each push button shall be as follows:

1. "RWP-201 E-Stop"
2. "RWP-202 E-Stop"
3. "RWP-203 E-Stop"
4. "RWP-204 E-Stop"

2.11 ETHERNET FIREWALL ROUTER BRICK TYPE/CELLULAR RADIO

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact Model: FL MGuard RS2000 VZW VPN

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental

1. Operating temperature: -4 Deg F to 140 Deg F
2. Operating humidity: 5 – 95% Non-condensing
3. Storage Temperature: -40 to 158 Deg F

D. Physical

1. Power Supply: redundant 24VDC

2. Microprocessor based managed type.

3. DIN rail mounting.

4. Port count and type shall be as shown in drawings as a minimum

E. Functional Performance

1. Per Port status LED indication.

2. Wire Speed switching.

3. 24 V DC voltage supply alarm contact

4. Management via IT standard SNMP (Simple Network Management Protocol)

5. Redundancy via Spanning Tree (IEEE 802.1D) or Rapid Spanning Tree (802.1w) Support.

6. Web Browser setup accessible.

7. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling.

8. VPN Tunnel Support up to 10 IPsec tunnels

9. Firewall rules with configurable stateful inspection

10. MAC filtering

11. IP address filtering

12. Protection against IP spoofing, DoS and Syn Flood Protection

2.12 CELLULAR ANTENNA

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:

1. Taoglas

a. Model: Pantheon MA710 3-in-1 GPS-GLONASS & Two Cellular (3G/4G/LTE) Screw-mount Antenna with 3M Cables

2. Parsec Technologies

a. Model: Chihuahua PRO ST Series

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Features:

1. 2 x Cellular 2G/3G/4G/ Antennas (MIMO)

   a. LTE/HSPA/GSM/GPRS/CDMA/UMTS

2. 1 x GPS/GLONASS 1575.42/1602MHz Active Antenna

3. IP67 Waterproof

4. High Efficiency/ Peak Gain Outdoor Antenna

5. RoHS Compliant

6. 2 x 3 meters CFD200 cable

7. 1 x 3 meters RG-174 cable

D. Environmental:

1. Operation Temperature: -40 Deg F to 185 Deg F

2. Storage Temperature: -40 Deg F to 194 Deg Fl

3. Operating Humidity: 5 – 95% Non-condensing

2.13 COAX CABLES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Times Microwave Systems LMR-600

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. Provide sufficient lengths of cables for installation for connection to all Communication Equipment with no splices.

D. Cable Construction

1. Inner Conductor Solid BCCAI

2. Dielectric Foam PE

3. Outer Conductor Aluminum Tape

4. Overall Braid Tinned Copper

5. Jacket Black PE.

E. Function/Performance:

1. Velocity of Propagation % 85

2. Dielectric Constant NA 1.32

3. Time Delay nS/ft (nS/m) 1.17 (3.83)

4. Impedance ohms 50

5. Capacitance pF/ft (pF/m) 23.4 (76.6)

6. Inductance uH/ft (uH/m) 0.058 (0.19)

7. Shielding Effectiveness dB >90

8. DC Resistance

a. Inner Conductor ohms/1000ft (/km) .53 (1.7)

b. Outer Conductor ohms/1000ft (/km) 1.2 (3.9)

9. Peak Power kW 40

F. Required Options/Accessories

1. Provide Surge Arrestors at the antenna connection and the entrance to the equipment per the NEC.

2. Provide antenna cable jumpers as required.

a. Times Microwave Systems LMR-240 Flexible Low Loss Communication Cable

2.14 PROCESS PANELS

A. Panels:

Tag	Name	Location
LRP-01	Level Relay Panel	Electrical Building
PRP-01	Discharge Pressure Relay Panel	Electrical Building

B. Ratings

1. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be 65,000 amperes RMS symmetrical at 480Y/277 Volts and 22,000AIC for 208Y/120 Volts. This includes all circuit breakers. Relay control units shall be tested and UL 508A labeled for the specified short circuit duty.

2. There shall be selective device coordination between the Main Breaker, Feeder Breakers and control circuit protective devices. When using a circuit breaker or fuses as a main protective device, the instantaneous trip levels of the main protective device shall be higher than the available fault current to the control panel. If fuses are utilized in the control panel design, the protective devices for 3 phase loads shall contain single phase protection of such equipment. If a fault occurs in the circuit of one load of a design with a backup load, the feeder protective device shall not remove both loads from the control system.

3. Use ground fault sensing on grounded wye systems.

4. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".

5. The control panel shall meet all applicable requirements of the National Electrical Code.

6. The control panel enclosure shall be NEMA rated as indicated in Section 26 00 00 of the Electrical Specifications.

7. For additional ratings and construction notes, refer to the Drawings.

C. Construction

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

2. Control units shall be arranged as shown on the Drawings.

3. Nameplates

a. External

1). Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X W', or equal. Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable. Nameplates shall be white with black letters.

2). There shall be a master nameplate that indicates supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.

3). Provide permanent warning signs as follows:

a). "Danger- High Voltage- Keep Out" on all doors.

b). "Warning- Hazard of Electric Shock- Disconnect Power Before Opening or Working On This Unit" on main power disconnect or disconnects.

b. Internal

1). Provide the panel with a UL 508A label.

2). Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special

1). Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

4. Control Devices and Indicators

a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, reinforced plastic, NEMA 4/4X/13. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.

b. Indicator lamps shall be LED type. Unless otherwise shown on the Drawings, lens color shall be Amber for ON or OPEN, Green for OFF or CLOSED, Red for FAIL or ALARM (LOW/HIGH LEVEL), and White for POWER ON. For all control applications, indicator lamps shall incorporate a push-to-test feature.

c. Mode selector switches (CUTOFF-BYPASS, HAND-OFF-AUTO etc.) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.

d. Pushbuttons shall be Red for START or OPEN, Green for STOP or CLOSE, mushroom Red for EMERGENCY STOP (Pull to Reset), and Black for RESET.

e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

5. Control and Instrument Power Transformers

   a. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100VA.

   b. Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

6. A failure alarm with horn and beacon light shall be provided when required or specified. Silence and reset buttons shall be furnished. Alarm horn and beacon shall be by Federal Signal; Crouse-Hinds, or equal, NEMA 4X for all areas except for NEMA 7 areas, which shall be NEMA 7/4X cast aluminum.

D. Enclosure Types

1. NEMA 4X 304L Stainless Steel enclosures for all areas, unless specifically stated otherwise, or shown on the Drawings.

   a. Wall Mounted

      1). Enclosures shall be NEMA Type 4X of 316 stainless steel with mounting lugs or brackets made on the enclosure suitable for wall mounting. Enclosures shall not have holes or knockouts. Enclosures shall not be less than .080 in. thick, gauge metal. All enclosures shall have continuous hinged, foam-in-place gasketed doors with handle latch, 3-point above 20" x 20". Screw-clamp latches shall not be acceptable. All enclosures shall have bonding provisions on door. Enclosures shall be LHCXXXXXXSS6 Series with Hoffman APWKXXXXNFSS Window Kit, where shown on the Drawings, as manufactured by Hoffman Engineering Co. or equal.

2. Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures. The enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

3. All enclosures shall be padlockable.

4. The enclosure outer door shall have a rear mounted pocket, containing laminated copies of the Control schematics.

E. Environmental Conditioning

1. Condensation Control

    a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned space.

        1). Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.

        2). Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.

        3). Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.

        4). Enclosure heaters shall be Hoffman type DAH or equal.

    b. Strip heaters may be provided if they are 240 volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromolox or equal.

        1). Strip heaters shall be Chromalox, Type OT, 1.5-in wide, 240 Volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314, or equal. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.

        2). A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177, or equal.

        3). The strip heater terminals shall be guarded by a protective terminal cover.

        4). High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, Product Code No. 263783, or equal.

    c. Each panel shall have a %" stainless steel condensate drain, installed on a stainless steel conduit hub, HGTZ Series, T&B or equal, in the bottom of the enclosure. Drain shall be 0-Z GedneyDBB-50SS, or equal.

2. Corrosion Control

    a. Provide corrosion protection in each control panel with a corrosion-Inhibiting vapor capsule as manufactured by Northern instruments; Model Zerust VC, or Hoffman Engineering; Model A-HCI, or equal.

F. Internal Wiring

1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full rating or frame size of the connected device, and as shown on the Drawings.

2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.

3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.

4. All wiring shall be tagged and coded with an Identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.

5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.

G. Field Installed Internal Wiring

1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal

3. In general, all conduit entering or leaving equipment shall be stubbed up into the bottom of the enclosure directly below the area in which the conductors are to be terminated, or from the top if shown on the Drawings. Conduits shall not enter the side unless approved in writing by the Owner/Engineer.

H. Terminal Blocks

1. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type and end barriers. Terminal blocks shall be rated for 600 volts except for control and instrumentation circuits, or 4-20 mA analog signal conductors.

2. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.

3. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.

4. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.

5. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

6. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.

7. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.

8. Control circuits, 120 volts and below, and 4-20 mA analog signal conductors shall be terminated with manufacturer's recommended insulated connectors.

9. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.

10. Provided ground terminal blocks for each twisted-shielded pair drain wire.

I. CONTROL RELAYS: Industrial type; contacts rated for 10 amps at 600 VAC; Allen-Bradley bulletin 700 type PK, Square D Class 8501 type X, or approved equal. Relays shall have the capability of having contact decks added in the field. Contacts shall be field convertible to normally open or normally closed. Coils and contacts shall each be replaceable without replacing any other part of the relay. Where control relays are in dictated on the Plans, industrial control relays shall be furnished whether the relay coil is operated with 120 VAC or 24 VDC. General purpose “plug-in” type relays shall not be acceptable.

J. INDICATING LIGHTS, SWITCHES, PUSHBUTTONS: Heavy duty and oil tight (30mm); Square d Class 9001 or approved equal. Pilot lights shall be push to test (Cluster LED type) and shall be Square d SK or approved equal.

K. MAIN CIRCUIT PROTECTIVE DEVICE

1. Unless otherwise shown on the Drawings, the main circuit protective device shall be a molded case (MCCB), 3 Pole, 600 Volt, fixed type, manually operated with stored energy closing mechanism. Trip device shall be solid state with adjustable long time pickup, and delay; adjustable short time pickup and delay; short time i2t switch.

2. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position. Where panels are shown or specified with inner and outer doors, disconnecting handles and controls shall be located on the inner door.

3. The overall short circuit withstand and interrupting rating of the equipment and devices shall be 65,000 amperes RMS symmetrical at 480Y/277 Volts and 22,000AIC for 208Y/120 Volts.

3.00 EXECUTION

3.01 INSTALLATION

A. All work shall be in accordance with manufacturer's recommended practices. Care shall be exercised to avoid damage to equipment during installation. Damaged equipment shall be replaced by Contractor at no expense to the Owner.

B. System equipment shall be installed where indicated in the Contract Documents. Power and signal connections between components shall provide the specified functions. Install according to equipment manufacturer's instruction.

C. The system Supplier Contractor shall utilize their own printers, monitors, and computers for programming, testing, and start-up. The use of the Owner's computers, monitors, or printers shall not be acceptable until the entire system has been installed, debugged, programmed, and operated to Engineer's satisfaction.

3.02 PROGRAMMING

A. The loop descriptions and diagrams shown in the Contract Documents are functional only and do not attempt to specify detail program coding that may be required. The CONTRACTOR shall utilize this functional information to develop complete application programming for the PLC equipment provided under this CONTRACT.

3.03 DOCUMENTATION

A. Following delivery to the site, the equipment manufacturer, in the presence of the Engineer, shall demonstrate operation of the complete system.

B. The CONTRACTOR shall provide documentation for all application software. Documentation system shall be diagrams in ladder-rung format, and shall show all input devices to the left of the left "power rail" and all outputs to the right of the right "power rail." The diagrams shall show all device codes and functional description used in the project manual, and shall also show PLC address codes, element codes, and I/O assembly codes, modules numbers, and terminal numbers.

3.04 TESTS

A. All elements of the Remote I/O system, both hardware and software, shall be tested to demonstrate that the total system satisfies all of the requirements of the Specifications.

B. The Contractor shall furnish and install the field instruments, remote input/output (RI/O), and interface equipment in a schedule to meet the construction sequencing.

C. As a minimum, the testing shall include the following:

1. Software Acceptance Tests (SAT)

2. Operational Readiness Tests (ORT)

3. Functional Demonstration Tests (FDT)

4. 30-Day Acceptance Test

D. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

E. All tests shall be conducted in accordance with Engineer-approved procedures and documented. Each specific test to be performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion.

F. Copies of signoff test procedures, forms, and checklists will constitute the required test documentation.

G. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulations techniques in the test procedure.

H. Coordinate all testing with other Contractors, the Owner, and the Engineer.

I. The Owner and/or Engineer will actively participate in many of the tests. The Owner and/or Engineer reserves the right to test or retest any and all specified functions whether or not explicitly stated in the approved test procedures. The Owner and/or Engineer reserves the right to observe and/or inspect the work during any phase.

J. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

3.05 SOFTWARE ACCEPTANCE TEST (SAT)

A. Prior to the start of the witnessed Software Acceptance Test (SAT), the entire system shall be installed on site, inspected and tested to ensure that it is fully operational and ready for the SAT demonstration testing.

B. All panels and assemblies of the subsystem shall be completely installed except I/O signals to field elements or devices shall not be connected. The system shall be inspected and tested to verify that they are in conformance with related submittals and the Contract Documents.

C. The Remote I/O Module and subsystem primary elements, shall be interconnected and tested to ensure that the system is fully operational. The system shall be operated without signals leaving or entering from the field elements or devices for at least one week to verify that it is capable of continuous operation. Outputs to and inputs from the excluded primary elements shall be simulated.

D. The system shall be tested, installed on site to demonstrate that it is operational and in conformance with the Contract Documents.

E. Notify the Engineer and Owner in writing a minimum of 30 days in advance of the proposed starting date for the Software Acceptance Test. At the time of notification, submit any revisions to the detailed test procedure previously approved by the Engineer in the Project System Plan.

F. The purpose of the test shall be to witness and verify the functionability, performance, and stability of the hardware and software. The system must operate continually for 24 hours without failure before the test shall be judged successful. Successful completion of this test shall be the basis for approval of the system.

G. Where hardware items are of standard manufacture and in current production, the manufacturer shall certify that applicable tests have been performed and met, in accordance with IEEE and ISA Standards, and be prepared to supply copies of data to Engineer upon request. Such statements shall accompany the equipment submittals called for in SUBMITTALS of this Section. Any assemblage of devices together with operating programs shall be tested together as provided herein.

H. The various tests performed during Software Acceptance Test shall be designed to demonstrate that the hardware and software fulfill all the requirements of the Contract Documents. The test conditions shall resemble, as closely as possible, actual conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no cost to the Owner.

I. Some of tests to be performed shall include, but not be limited to, the following:

1. Building and loading the system database.

2. Conduct online modifications to the database.

3. Demonstrate operability of the interfaces (hardware and software).

4. Demonstrate operability of the data communication network.

5. Demonstrate all system software functions specified.

6. Verify the displays and interactive capabilities of an operator's console.

7. Simulate selected normal and abnormal operating conditions to verify the performance of the monitoring and control functions.

8. Simulate every I/O point by opening or shorting digital inputs, inject appropriate signals into every analog input point, and measure the output signal from each analog output point.

J. All deficiencies identified during these tests shall be corrected and retested prior to completing the Software Acceptance Test.

K. The following documentation shall be made available to the Engineer at the test site both before and during the Software Acceptance Test.

1. All drawings and specifications, addenda, and change orders.

2. Master copy of the test procedure.

3. List of the equipment to be tested including make, model, and serial number.

4. Design-related hardware submittals applicable to the equipment being tested.

5. Preliminary software documentation submittal.

L. The daily schedule during these tests shall be as follows:

1. Testing and meetings: Nominally 8 hours per day; 24 hours per day if required to meet schedule.

2. Morning meetings to review the day's test schedule.

3. Evening meetings to review the day's test results and to review or revise the next day's test schedule.

M. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the Engineer and Owner.

N. The Engineer will observe each test once on a pass-fail basis. The Engineer alone has the authority to determine if a test passes or fails. Only four (4) fifteen minute windows per day will be allowed during the test procedure to make corrections to software and successfully pass a re-test. Otherwise, that test will be declared a failure. If a test fails, it will be put on a retest schedule. If other tests to follow rely on a particular test passing, then the following tests will also be placed on a retest schedule even though they were not tested before. Retesting shall not interrupt the test schedule. The CONTRACTOR may schedule retest days during the testing period, but not more than two per week. All retesting shall only occur on a day designated in the schedule or at the end of testing.

O. All time and expense incurred by the Engineer and/or Owner's staff for all retests shall be borne by the CONTRACTOR and paid to the Owner. Time and expense incurred shall be on a time and material basis tracked by the Engineer and Owner for their own staff and presented to the CONTRACTOR on a periodic basis.

P. The CONTRACTOR shall expedite the correction of any deficiency discovered during testing. The CONTRACTOR shall have personnel from each trade to standby during the test period to immediately correct, or adjust any item of software or hardware or equipment causing a test to fail.

3.06 OPERATIONAL READINESS TEST (ORT)

A. General: Prior to start-up, the installed system shall be certified (inspected, tested, and documented) that it is ready for operation. Download all database on job computers from this test onwards. The Owner and Engineer shall be notified when ORT starts. Copies of ORT forms that have been signed off by the CONTRACTOR shall be copied and sent to the Owner and Engineer on a daily basis for record purposes only. No signature by the Engineer or Owner is required for ORT forms.

B. Loop/Component Inspections and Tests: The 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. Actual real-time signals generated from the field devices shall be used. Simulation of field signals shall not be permitted. This test is intended to actually operate the entire process and to find and correct all real-time operational deficiencies.

1. The Loop/Component Inspections and Tests shall be implemented using Engineer-approved forms and checklists.

a. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following:

1). Project name

2). Loop number

3). Tag number for each component

4). Checkoffs/signoffs for each component

a). Tag/identification

b). Installation

c). Termination - wiring

d). Termination - tubing

e). Calibration/adjustment

5). Checkoffs/signoffs for the loop

a). Panel interface terminations

b). I/O interface terminations

c). I/O signal operation

d). Inputs/outputs operational: received/sent, processed, adjusted

e). Total loop operational

f). Space for comments

g). Space for signoff by Contractor

b. Each active analog subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall include the following:

1). Project name

2). Loop number

3). Component tag number or I/O module number

4). Component code number analog system

5). Manufacturer (for analog system element)

6). Model number/serial number (for analog system)

7). Summary of functional requirements, for example:

a). For indicators and recorders: Scale and chart ranges

b). For transmitters/converters: Input and output ranges

c). For computing elements: Function

d). For controllers: Action (direct/reverse) control modes (PID)

e). For switching elements: Unit range, differential (fixed/adjustable), reset (auto/manual)

f). For I/O modules: Input or output

8). Calibrations; for example:

a). For analog devices: Required and actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling

b). For discrete devices: Required and actual trip points and reset points

c). For controllers: Mode settings (PID)

d). For I/O modules: Required and actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling

9). Space for comments

10). Space for signoff by the Contractor

2. Maintain the Loop Status Reports and Component Calibration Sheets at the jobsite and make them available to the Engineer and Owner upon request.

3. These inspections and tests do not require witnessing. However, the Engineer will review the Loop Status Reports and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Test. Any deficiencies found shall be corrected.

3.07 FUNCTIONAL DEMONSTRATION TEST (FDT)

A. Once ORT has been completed and operational readiness has been confirmed, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with the Contract Documents. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and component-by-component basis. This test shall be scheduled and conducted only after all new pipeline construction is complete and the new pipeline and metering construction is completed and operational.

B. Loop-specific and non-loop-specific tests shall be the same as specified under SOFTWARE and OPERATIONAL READINESS TESTS except that the entire installed PICS shall be tested and all functions demonstrated.

C. Simulation of field signals, or simulation of the response of the process, or the response of individual components, or the functions being monitored or controlled, shall not be permitted. Simulation may be permitted with the express permission of the Engineer. The decision to simulate is the Engineer's alone. The Contractor shall include in the Contract Price the time necessary to wait for all process responses.

D. Updated versions of the documentation called for under SOFTWARE and OPERATIONAL READINESS TESTS shall be made available to the Engineer at the jobsite both before and during the test. In addition, one copy of the approved Instrumentation O&M Manual shall be made available to the Engineer at the jobsite both before and during testing. The approved schedule shall be followed strictly on an item-by-item basis. Combining of test items shall be at the discretion of the Engineer alone. The Contractor shall include in the Control Price adequate time necessary to complete each test item one at a time.

E. The daily schedule called for under SOFTWARE and OPERATIONAL READINESS TESTS shall also be followed during the Functional Demonstration Test.

F. The Engineer will observe each test once on a pass-fail basis. The Engineer alone has the authority to determine if a test passes or fails. Only one (1) fifteen minute window per day will be allowed during the test procedure to make corrections to software or to field equipment and successfully pass a re-test; otherwise, that test will be declared a failure. If a test fails, it will be put on a retest schedule. If other tests to follow rely on a particular test which has failed, then the following tests will also be placed on a retest schedule even though they were not tested. Retesting shall not interrupt the test schedule. The Contractor may schedule retest days during the testing period, but not more than two per week. All retesting shall only occur on a day designated in the schedule or at the end of testing.

G. All time and expense incurred by the Engineer and/or Owner's staff for all retests shall be borne by the Contractor and paid to the Owner. Time and expense incurred shall be on a time and material basis tracked by the Engineer and Owner for their own staff and presented to the Contractor on a periodic basis.

H. The Contractor shall expedite the repair or correction of any deficiency discovered during testing. The Contractor shall have personnel representing each trade to standby during the test period to immediately correct, repair, or adjust any item of hardware, software or field equipment causing a test to fail.

I. The system shall operate continuously for 100 hours without failure before this test will be considered successful.

3.08 30-DAY ACCEPTANCE TEST

A. All database errors must be corrected prior to the start of the 30-Day Acceptance Test. The 30-Day Acceptance Test will not be considered successful until all databases are correct.

B. Any malfunction during the test shall be analyzed and corrections made by the Contractor. The Engineer and Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of the test. The cost of a retest shall be borne by the Contractor as specified.

C. After completion of the Functional Demonstration Test and Plant Start-up, the Contractor shall be responsible for operation of the entire System for a period of 30 consecutive days, under conditions of full plant process operation, without single non-field repairable malfunction.

D. During this test, Contractor personnel shall be present as required. The Contractor shall provide personnel for this test who have an intimate knowledge of the hardware and software of the system and also are familiar with the overall plant process. The Supplier shall be on-site a minimum of 8 hours a day and be on call for the rest of the day, during the entire 30-Day Acceptance Test. During the rest of the test period the supplier shall be available and on the job site within 48 hours of any failure.

E. While this test is proceeding, the Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.

F. Any malfunction, during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the Contractor's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.

G. Upon completion of repairs, by the Supplier, the test shall be repeated as specified herein.

H. In the event of rejection of any part or function, the Supplier shall perform repairs within 5 days or replacement within 30 days.

I. Upon successful completion of the 30-Day Acceptance Test, approval of all as-built drawing and O&M Manuals, completion of all related Owner training, and delivery of all spare, expendable, and test equipment, the systems shall be considered substantially complete and the warranty period shall commence.

3.09 TRAINING

A. Provide an integrated training program for the Owner's personnel for one day, both at the Supplier's factory or training center and at the jobsite. The Contractor shall submit a detailed training schedule and syllabus for approval. Tailor the training program to meet the specific needs of the Owner's personnel. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

B. The training shall be carried out by technically competent and experienced instructors.

C. An "instructor week" shall consist of 40 hours of actual instruction time. An "instructor day" shall consist of 8 hours of actual instruction time. Provide instruction on any or all three working shifts as needed to accommodate the Owner's personnel schedule. The actual training schedule shall be coordinated with the Owner.

D. The Contract shall hire a professional firm regularly engaged in video tape and/or film productions to video tape of all of the factory and on-site training sessions. The video tape and all rights there to shall become the property of the Owner. The Owner may re-use or distribute the video tape at their discretion.

3.10 OPERATIONS AND MAINTENANCE TRAINING

A. O&M training for each subsystem shall be in accordance with the requirements specified under the related Instrumentation specification sections.

B. All training shall be given using only equipment identical to the equipment provided on this Contract or currently owned by the Owner.

C. Unless otherwise specified, hardware maintenance training shall be suitable for instrument technicians who have at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

3.11 ON-SITE SUPERVISION

The Supplier shall provide, on-site, an experienced resident engineering manager to supervise and coordinate all of the on-site activities. This resident engineering manager shall be on-site as required during the total period to affect all the activities relating to the PICS.

3.12 START-UP AND TESTING TEAM

A. The Supplier shall provide, on-site, a team of experienced engineering, technician, trades personnel, and software/configuring personnel during the total construction period to:

1. Thoroughly check the installation, termination, and adjustment of all the subsystems and their components.

2. Perform and complete all on-site tests.

3. Provide start-up assistance.

END OF SECTION

40 90 02.01 SCADA LOOP DESCRIPTIONS

1.00 GENERAL

1.01 GENERAL

A. All alarms and changes in the system shall be recorded to display time, shift manager and time alarm acknowledged. Trend shall record display analysis, level, or flow and shall show date and time. Operator log in shall display date and time. All information shall be saved to an Excel spread sheet and all information shall be displayed on SCADA. Contractor shall coordinate with Owner on instrumentation set points.

B. This and the following section describe the process control narratives for the Collier's Ferry Raw Water Pump Station. The control narratives are not intended to be an exhaustive list of all components required to execute control strategies. Rather they are a supplement to the drawings, schedules, and other specification sections.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.02 CLARIFICATIONS

A. Refer to the I/O list for a complete list of the input/output signals to each SCADA cabinet.

B. The following control narrative does not provide a full list of the data to be pulled from each data highway.

C. Abbreviations

a. OWS = Operator Workstation located remotely for monitoring and control
b. PLC = Programmable Logic Controller
c. VFD = Variable Frequency Drive

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 01 33 00 "Document Management" as specified herein.

2.00 LOOP DESCRIPTIONS

2.01 RAW WATER PUMPS (LOOPS 201, 202, 203, 204)

A. Each pump shall have three modes of operation: Local, SCADA – Automatic, and SCADA - Manual. The pumps will normally run in SCADA – Automatic mode.

B. When the pilot switch at the VFD is in the OFF position, the pump shall show up as "OUT OF SERVICE" on the OWS.

C. Only one pump will be started at a time.

D. The contractor shall program a control function that shall provide for the operation of the pumps under normal conditions and shall display the total run time for each pump.

E. In SCADA – Manual mode.

1. In SCADA – Manual mode the VFDs will receive a user input for a run signal and speed setpoint. The pumps will turn on and speed up until the speed feedback matches the user defined speed setpoint.
2. Pumps will continue to run until the VFD receives a stop signal from SCADA.

F. In SCADA – Automatic mode.

a. Upon a recovery from a power failure, the PLC shall be programmed to automatically sequence the restart of the pump(s). The sequencing restart shall be configured such that only one pump starts at a time.

b. In SCADA – Auto mode SCADA will receive a user input for flow. SCADA shall include programming to maintain the flow setpoint as measured by the discharge flow meter (FIT-250)

c. The number of pumps that will run simultaneously shall be according to the table below:

Flow	# of Pumps
7.5-15 MGD	1
15-27 MGD	2
27-45 MGD	3

d. Each pump will turn on in sequence to their minimum speed, then all pump(s) will increase speed until the discharge flow matches the user defined setpoint.

e. If one pump is running and the flow demand increases above 15 MGD, then SCADA programming will tell the lead pump will decelerate to minimum speed, the second pump will turn on, and both pumps will accelerate together until the demand is met.

f. If two pumps are running and flow demand increases above 27 MGD (90% capacity of two pumps) then both pumps will decrease to minimum speed, the third pump will turn on and all three pumps will accelerate together until the demand is met.

g. If three pumps are running and flow demand drops below 27 MGD, then the longest running pump will turn off and the other two pumps will adjust speed to meet the demand. SCADA programming will follow a first in, first out sequence when flow demand decreases.

h. If two pumps are running and flow demand drops below 15 MGD, then the longest running pump will turn off and the other pump will adjust speed to meet the demand. SCADA programming will follow a first in, first out operation when flow demand decreases.

i. If one pump is running and flow demand drops below 7.5 MGD, then the pump will shut off.

j. SCADA shall include programming to initiate a stop signal to all VFDs when the level of LPE-101 (transmitted through LIT-1) drops below a user defined setpoint.

G. PUMP CONTROL LOGIC AT THE VFD

1. Normal Start Sequence: The start sequence is initiated when the motor is called to start by either the pushbutton located as the VFD motor controller or through a start signal from SCADA. The motor controls will start the pump motor upon confirmation that all permissives have been met. The pump control valve receives an Open and Close command from the VFD.
   a. Upon start command the VFD will send an Open command to the valve. Once the valve has reached 5% open, the motor will be called to run. The valve will continue to open until it reaches 100% open.
   b. Start Permissives: Permissives that need to be met in order to start:
      1) Pumps cannot start if the well level is low.
      2) Pump cannot start if any of the items causing an Emergency Stop has occurred and not been cleared.
      3) The pump control valve has been closed for at least 15 minutes.
2. Normal Stop Sequence: The normal stop sequence is initiated when the motor is called on to stop by the stop pushbutton located at the VFD, a stop signal from SCADA, or a low level lockout signal from LRP-01. In a normal stop, the pump control valve will begin to close and once the valve reaches 5% open, the pump will decelerate before shutting off completely.
3. Low Level Lockout: If the well level drops below float switch “LSLL-1” a lockout signal will be triggered at Level Relay Panel “LRP-01”. The lockout will be transmitted to all VFDs and initiate a normal stop sequence. The lockout will remain and prevent any pumps from starting until water level rises above switch “LSLL-1”
4. Emergency Stop Sequence: An emergency stop will cause the motor to stop immediately. The following will cause an emergency stop.
   a. E. Stop pushbutton has been pressed at the motor or VFD
   b. E.Stop has been initiated from SCADA
   c. Pump motor alarm
   d. VFD fault
   e. Loss of line pressure
   f. High line pressure
   g. Valve failure

2.02 ELECTRICALLY OPERATED PUMP CONTROL VALVES (BFV-201, BFV-202, BFV-203, BFV-204)

A. The pump control valve receives an Open and Close command from the VFD. Refer to 2.01, G for a description of the valve operation in coordination with the VFD controls.

B. A 4-20mA analog signal shall be sent directly to SCADA to indicate the position of the valve.

2.03 DISCHARGE LINE PRESSURE TRANSMITTER (PIT-201, PIT-202, PIT-203, PIT-204)

A. Located at the pump station on the discharge of each pump.

B. The pressure transducer/transmitter shall be used to measure discharge line pressure.

1. Line piping pressure shall be converted to pressure lockouts at the Pressure Relay Panel and re-transmitted in 4-20mA to SCADA.
2. Pressure lockout alarms shall be transmitted to the associated VFD. When a High Discharge Pressure alarm is received at the VFD, the associated pump will turn off.
3. The pressure setpoint that triggers a lockout alarm shall be adjustable. The lockout pressure setpoint shall be coordinated with the Owner.
4. The discharge pressure level shall be displayed on the Operator Workstation (OWS).
5. Pressure shall be logged.

2.04 FLOW METER (FIT-250)

A. Measures the pump station discharge flow.

B. The flow rate shall be displayed locally and on the OWS. SCADA shall trend flow.

C. SCADA shall record and display total flow based on a flow totalizer set at 1000 gallons per pulse.

2.05 AUTOMATIC TRANSFER SWITCH (ATS-1)

A. When there is a loss of power from the electric utility, the Automatic Transfer Switch shall send a signal to the generator panel initiating a Run Generator command.

B. Signals shall be sent to SCADA indicating whether ATS-1 is receiving Generator or Utility power.

2.06 BACKUP GENERATOR

A. The generator shall receive a digital run command signal from ATS-1 upon loss of utility power. In normal operation, the generator will run and stop based upon input from ATS-1.

B. Digital signals shall be sent to SCADA to indicate statuses critical to the generator operation as described in the project Drawings and Specifications.

C. An ethernet data highway shall connect to SCADA to indicate generator statuses as described in Specification 26 32 13 2.09 H.

2.07 INTRUSION DETECTION

A. When the intrusion detector has been triggered an alarm shall be sent to SCADA. The following intrusion detectors are included:

a. Electrical Building Double Doors (XS-311)

b. Electrical Building Single Door (XS-312)

2.08 RTU CABINET (RTU-1)

A. SCADA shall display the following:

a. Door Open
b. UPS Fault Alarm
c. DC Power Fail Alarm
d. AC Power Fail Alarm

END OF SECTION

40 90 02.02 POINTS LIST

Line Item No.	Loop	Point Type	Equipment Tag	Signal Description	Function	I/O Char.	Isolated/Loop	To RTU at
	101	AI	LPE-101	Wet Well Level	Indication	4-20 mA	Isolated	RTU Cabinet
	201	AI	PIT-201	Discharge Pressure	Indication	4-20 mA	Isolated	RTU Cabinet
	202	AI	PIT-202	Discharge Pressure	Indication	4-20 mA	Isolated	RTU Cabinet
	203	AI	PIT-203	Discharge Pressure	Indication	4-20 mA	Isolated	RTU Cabinet
	204	AI	PIT-204	Discharge Pressure	Indication	4-20 mA	Isolated	RTU Cabinet
	250	AI	FIT-250	Discharge Flow	Indication	4-20 mA	Isolated	RTU Cabinet
	101	DI	LRP-01	Bypass Enabled	Status			RTU Cabinet
	101	DI	LRP-01	Low Level Cutoff	Status			RTU Cabinet
	201	DI	VFD-201	Start Permissive	Status			RTU Cabinet
	201	DI	VFD-201	E. Stop at VFD	Alarm			RTU Cabinet
	201	DI	VFD-201	E. Stop at Pump	Alarm			RTU Cabinet
	201	DI	VFD-201	SCADA Enable	Status			RTU Cabinet
	201	DI	VFD-201	Local Enable	Status			RTU Cabinet
	201	DI	VFD-201	VFD Running	Status			RTU Cabinet
	201	DI	VFD-201	VFD Stopped	Status			RTU Cabinet
	201	DI	VFD-201	VFD Fault/Trip	Alarm			RTU Cabinet
	201	DI	VFD-201	No Pressure	Alarm			RTU Cabinet
	201	DI	VFD-201	High Pressure	Alarm			RTU Cabinet
	201	DI	VFD-202	Pump Monitor Alarm	Alarm			RTU Cabinet
	201	DI	VFD-201	Valve Failure	Alarm			RTU Cabinet
	201	DI	VFD-201	Valve Open	Status			RTU Cabinet
	201	DI	VFD-201	Valve Closed	Status			RTU Cabinet
	201	DI	VFD-201	Valve Remote Mode	Status			RTU Cabinet
	202	DI	VFD-202	Start Permissive	Status			RTU Cabinet
	202	DI	VFD-202	E. Stop at VFD	Alarm			RTU Cabinet
	202	DI	VFD-202	E. Stop at Pump	Alarm			RTU Cabinet
	202	DI	VFD-202	SCADA Enable	Status			RTU Cabinet
	202	DI	VFD-202	Local Enable	Status			RTU Cabinet
	202	DI	VFD-202	VFD Running	Status			RTU Cabinet
	202	DI	VFD-202	VFD Stopped	Status			RTU Cabinet
	202	DI	VFD-202	VFD Fault/Trip	Alarm			RTU Cabinet
	202	DI	VFD-202	No Pressure	Alarm			RTU Cabinet
	202	DI	VFD-202	High Pressure	Alarm			RTU Cabinet
	202	DI	VFD-202	Pump Monitor Alarm	Alarm			RTU Cabinet
	202	DI	VFD-202	Valve Failure	Alarm			RTU Cabinet
	202	DI	VFD-202	Valve Open	Status			RTU Cabinet
	202	DI	VFD-202	Valve Closed	Status			RTU Cabinet
	202	DI	VFD-202	Valve Remote Mode	Status			RTU Cabinet
	203	DI	VFD-203	Start Permissive	Status			RTU Cabinet

Line Item No.	Loop	Point Type	Equipment Tag	Signal Description	Function	I/O Char.	Isolated/Loop	To RTU at
	203	DI	VFD-203	E. Stop at VFD	Alarm			RTU Cabinet
	203	DI	VFD-203	E. Stop at Pump	Alarm			RTU Cabinet
	203	DI	VFD-203	SCADA Enable	Status			RTU Cabinet
	203	DI	VFD-203	Local Enable	Status			RTU Cabinet
	203	DI	VFD-203	VFD Running	Status			RTU Cabinet
	203	DI	VFD-203	VFD Stopped	Status			RTU Cabinet
	203	DI	VFD-203	VFD Fault/Trip	Alarm			RTU Cabinet
	203	DI	VFD-203	No Pressure	Alarm			RTU Cabinet
	203	DI	VFD-201	High Pressure	Alarm			RTU Cabinet
	203	DI	VFD-202	Pump Monitor Alarm	Alarm			RTU Cabinet
	203	DI	VFD-203	Valve Failure	Alarm			RTU Cabinet
	203	DI	VFD-203	Valve Open	Status			RTU Cabinet
	203	DI	VFD-203	Valve Closed	Status			RTU Cabinet
	203	DI	VFD-203	Valve Remote Mode	Status			RTU Cabinet
	204	DI	VFD-204	Start Permissive	Status			RTU Cabinet
	204	DI	VFD-204	E. Stop at VFD	Alarm			RTU Cabinet
	204	DI	VFD-204	E. Stop at Pump	Alarm			RTU Cabinet
	204	DI	VFD-204	SCADA Enable	Status			RTU Cabinet
	204	DI	VFD-204	Local Enable	Status			RTU Cabinet
	204	DI	VFD-204	VFD Running	Status			RTU Cabinet
	204	DI	VFD-204	VFD Stopped	Status			RTU Cabinet
	204	DI	VFD-204	VFD Fault/Trip	Alarm			RTU Cabinet
	204	DI	VFD-204	No Pressure	Alarm			RTU Cabinet
	204	DI	VFD-204	High Pressure	Alarm			RTU Cabinet
	204	DI	VFD-204	Pump Monitor Alarm	Alarm			RTU Cabinet
	204	DI	VFD-204	Valve Failure	Alarm			RTU Cabinet
	204	DI	VFD-204	Valve Open	Status			RTU Cabinet
	204	DI	VFD-204	Valve Closed	Status			RTU Cabinet
	204	DI	VFD-204	Valve Remote Mode	Status			RTU Cabinet
	250	DI	FIT-250	Flow Totalizer	Status			RTU Cabinet
	301	DI	ATS-1	ATS Position	Status			RTU Cabinet
	301	DI	ATS-1	ATS Alarm	Alarm			RTU Cabinet
	301	DI	ATS-1	Utility Power Available	Status			RTU Cabinet
	301	DI	ATS-1	Generator Mode	Status			RTU Cabinet
	302	DI	1250kW Generator	Low Fuel	Alarm			RTU Cabinet
	302	DI	1250kW Generator	Common Alarm	Alarm			RTU Cabinet
	302	DI	1250kW Generator	Battery Charger	Status			RTU Cabinet
	302	DI	1250kW Generator	Running Status	Status			RTU Cabinet
	302	DI	1250kW Generator	Low Oil Pressure	Alarm			RTU Cabinet
	302	DI	1250kW Generator	Fault Alarm	Alarm			RTU Cabinet
	360	DI	RTU Enclosure	Enclosure Intrusion Alarm	Alarm			RTU Cabinet

Line Item No.	Loop	Point Type	Equipment Tag	Signal Description	Function	I/O Char.	Isolated/Loop	To RTU at
	360	DI	RTU Enclosure	Utility Power Fail Alarm	Alarm			RTU Cabinet
	360	DI	RTU Enclosure	DC Fail Alarm	Alarm			RTU Cabinet
	360	DI	RTU Enclosure	UPS Fault	Alarm			RTU Cabinet
	310	DI	XS-311	Elec. Building Intrusion Alarm	Alarm			RTU Cabinet
	310	DI	XS-312	Elec. Building Intrusion Alarm	Alarm			RTU Cabinet
	201	DO	P1-VFD	SCADA E. Stop	Control			RTU Cabinet
	201	DO	P1-VFD	SCADA Start	Control			RTU Cabinet
	201	DO	P1-VFD	SCADA Stop	Control			RTU Cabinet
	202	DO	P2-VFD	SCADA E. Stop	Control			RTU Cabinet
	202	DO	P2-VFD	SCADA Start	Control			RTU Cabinet
	202	DO	P2-VFD	SCADA Stop	Control			RTU Cabinet
	203	DO	P3-VFD	SCADA E. Stop	Control			RTU Cabinet
	203	DO	P3-VFD	SCADA Start	Control			RTU Cabinet
	203	DO	P3-VFD	SCADA Stop	Control			RTU Cabinet
	204	DO	P4-VFD	SCADA E. Stop	Control			RTU Cabinet
	204	DO	P4-VFD	SCADA Start	Control			RTU Cabinet
	204	DO	P4-VFD	SCADA Stop	Control			RTU Cabinet
	201	Data Highway	P1-VFD	VFD Data Highway	Status/Control			RTU Cabinet
	202	Data Highway	P2-VFD	VFD Data Highway	Status/Control			RTU Cabinet
	203	Data Highway	P3-VFD	VFD Data Highway	Status/Control			RTU Cabinet
	204	Data Highway	P4-VFD	VFD Data Highway	Status/Control			RTU Cabinet
	302	Data Highway	Backup Generator	Generator Data Highway	Status			RTU Cabinet
	350	Data Highway	Switchboard Power Meter	Power Meter Data Highway	Status			RTU Cabinet
	201-204	Data Highway	Central Pump Unit	Pump Monitor Data Highway	Status			RTU Cabinet

44 42 56.04 SUBMERSIBLE PUMPS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install four new submersible raw water pumps, valves, check valves, pressure gauge assemblies, air release valve, piping, access hatches, and vents as indicated on the plans, and new control panel(s). Coordinate wet well access doors with the slide rails. Test equipment in accordance with Paragraph 1.02 of this Section.

B. The pump supplier shall furnish discharge elbows, pumps, guiderails, brackets, anchor bolts and anchor bolt layouts and bases, lifting chains and grip eye systems, and power cables as indicated on the plans.

C. Provide safety grate at each of the access doors to the wet well at the lift station. Verify actual size of the access doors. Installation of the safety grate shall be in accordance with the manufacturer's recommendations and the manufacturer shall provide an Equipment Installation Report certifying that it was installed properly. The manufacturer shall furnish brackets, anchor bolts and anchor bolt layouts and appurtenances required for the installation of the safety grate.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Flygt.

2. KSB.

B. Pumping units and motors shall be the product of manufacturers who have had at least ten (10) years of successful experience in the design, manufacturing and application of pumping units of similar type, size, and performance capabilities as specified. The Pump Manufacturer shall have at least five similar pumps of the model, type, and size of pump proposed in service and operational for at least the last five (5) years. It will be acceptable for the manufacturer to meet the pump installation experience requirements by referencing installations belonging to the pump's heritage line (previous ownership of the pump by a different company). The pumps referenced for the experience requirement shall be the same pump being proposed and the pump shall not have undergone substantial, material changes in engineering, design, and/or hydraulic characteristics.

C. Equipment Manufacturer shall maintain a quality assurance system in compliance with ISO 9001:2008 during the life of the contract.

D. Manufacturer's Representative for Startup and Testing: The services of the Manufacturer's technical representative shall be provided for pre-startup installation checks, startup assistance, training of Owner's operating personnel, troubleshooting and other services as required in Section 01 75 00 "Starting and Adjusting."

E. The pump supplier shall also provide all of the maintenance required for the first year of operation including the following as a minimum:

1. After 60 days operation, run each pump and record voltage and amperage, pull each pump, open the volute and examine the condition of the volute, impeller, and wear rings. Check condition of oil in seal chambers and condition of coating system on motor housing. Perform any necessary repair under terms of the warranty. Prepare a field service report.

2. After 12 months operation, repeat procedure described above. Change oil in the seal chambers.

F. Testing:

1. Factory Testing

a. Each pump and motor shall be performance tested at the factory. All pumps shall be tested with motor cables to be supplied with the pumps. Three copies of certified test reports, including actual test records, shall be submitted and approved by the Engineer prior to shipment of the equipment.

b. Each pump shall be tested for performance at the factory to determine the head vs. capacity, and motor input power for the full speed at which the pumps are specified and shown on a certified performance test curve as continuous functions throughout the pump's performance range.

c. Tests of models, prototypes or similar units will not be acceptable. All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute, latest edition.

d. Pumps shall be tested at maximum rated speed and minimum operating speed and with the complete pump assembly. The pumps shall be tested at the minimum available suction submergence as specified or shown on the Plans. The pumps may be tested with calibrated factory test motor and VFD.

e. Tests shall show no minus tolerance with respect to capacity or total head at the specified conditions.

f. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

g. Following completion of factory performance tests, the Equipment Manufacturer shall furnish to the Engineer for review and approval certified copies of all test data and test curves for each pump. Test curves shall include actual reduced speed test curves of 50%, 60%, 70%, 80%, and 90% speeds. The Engineer shall promptly review test data and, upon determining that the pump meets contract requirements, authorization will be given for shipment. Shipment shall not be made without written approval of test data by the Owner.

h. The pump manufacturer shall also furnish the motors, and shall be responsible to coordinate the design, testing, and installation of the pump and motor as a "pumping unit". In addition, the pump manufacturer shall be fully responsible for coordination with the VFD manufacturer to ensure proper sizing and compatibility

of the pumping system and VFD drive. The pumping system must be a complete and integrated package

2. Field Testing – as discussed below under Field Quality Control.

3. Failed factory or field tests shall result in the manufacturer correcting the issue and providing equipment that meets performance requirements at no additional cost to the Owner.

G. Marking

1. Pump and motor shall each have a standard Manufacturer's stainless steel nameplate securely affixed with tapping screws in a conspicuous place, showing the ratings, speed, rotation direction, serial number, model number, manufacturer, and other pertinent data.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings:

a. Shop drawings shall include a complete description of the equipment offered including control and mounting system. Shop drawings shall include catalog cuts and pertinent engineering data required to fully evaluate the equipment. Characteristic curves shall be submitted with the shop drawings showing the capacity, head, efficiency, and brake horsepower throughout the full operating range of the pump. Complete specifications on the control equipment including a list of optional features shall be submitted with the shop drawings. Submittal data shall be in such form and so presented that the Engineer may readily review the data.

b. The Equipment Manufacturer shall submit with the shop drawings a list of 20 similar installations in Texas which have been in satisfactory operation for at least two years. Shop drawings not including this required information will not be accepted. Also, manufacturer must furnish evidence of having an authorized fully staffed and stocked service facility within 150-mile radius of the jobsite as well as having 24-hour parts availability.

c. Data sheets supplying the following information for the pumping units shall be submitted with the shop drawings.

1). Pump:

Make and type of pump	
Speed	___ rpm
Horsepower at rated head	___ HP

2). Pump:

Total weight (pump and motor)	___ lb.
Rated capacity and head on pump curve	

3). Motor:

Make and type of motor	
Brake horsepower of motor	___ HP
Locked Rotor Current at full nameplate voltage	___ amps
Motor Voltage Phase	___ phase
Motor service factor	
Insulation class and temperature rise at service factor load	

d. Shop drawings shall be supplied to ensure successful installation and operation of the control system and shall consist of all of the following:

1). Sufficient detail to evaluate compliance with these specifications.

2). A detailed component list including manufacturer and catalog number.

3). A custom wiring diagram for this specific application to facilitate and insure accurate field connections to the control panel by electrical installation personnel.

4). A description of operation for the control system.

5). An enclosure dimension print.

2. Operation and Maintenance Manuals:

a. Manuals shall be prepared by the equipment Manufacturer per Section 01 33 04 "Operation and Maintenance Data" and shall incorporate storage and installation instructions and operation and maintenance procedures, appropriate final certified shop drawings, performance curves, and test data. Manuals may be Manufacturer's standard instructions, but shall be supplemented as necessary to cover any special feature not included in standard material. Submit preliminary manuals for review prior to delivery of the equipment.

3. Certified Laboratory Test Reports

4. Certifications

a. Certification of Equipment Coordination: The pump manufacturer shall submit a certification signed by each of the pump, motor, and VFD manufacturers stating that they have reviewed each other's submittal and certify that the pump, motor, and VFD will operate as a complete pumping unit capable of continuously meeting the performance criteria.

b. Certification of Installation: The pump manufacturer shall review the project drawings and provide a certification that the pump is capable of operating and meeting the performance criteria within the confines of the project wet well as shown on the plans and shall be able to be installed and retrieved by operators without removing structural members.

1.04 STANDARDS

A. American Water Works Association (AWWA)

B. American National Standards Institute (ANSI)

C. American Society of Mechanical Engineers (ASME)

D. American Standards for Testing and Materials (ASTM)

E. National Electrical Manufacturers Association (NEMA)

F. Test Code of the Hydraulic Institute Standards (HIS)

G. Institute of Electrical and Electronic Engineers (IEEE)

H. Underwriters Laboratories (UL)

I. National Electrical Code (NEC)

1.05 DESIGN CONDITIONS

A. The pumps shall be designed to handle raw water on a continuous duty basis and shall be capable of passing a 3-inch non-compressible sphere. Pumps shall be guaranteed free from excessive cavitation and/or vibration (as specified by the Hydraulic Institute) throughout the system performance range. The pumps shall meet the operating conditions as specified and shall be designed to operate on a continuous duty basis.

B. Design conditions for the pumps shall be as specified. Attached system head curve shows the system heads at the design conditions at which the pumps will operate, and the pumps will operate alone and in parallel with other pumps.

C. Refer to Paragraph 3.04 for schedule of performance requirements.

1.06 DELIVERY AND STORAGE

A. The Vendor shall be responsible for delivery of the pump, motor, and accessories, f.o.b. to the job site or to such storage site as may be designated by the OWNER or Construction CONTRACTOR, in good condition and undamaged.

B. Unloading and storage of the equipment shall be the responsibility of the Construction CONTRACTOR who shall inspect the equipment for apparent damage. Equipment which is found to be damaged shall not be accepted until properly repaired or replaced by the Vendor.

C. The pumps, motors, and accessories shall be stored indoors. When this equipment is stored indoors, it shall never be in direct sunlight and the indoor temperature shall be maintained at a level satisfactory to the OWNER. The CONTRACTOR is responsible for providing the indoor storage facility or enclosure.

D. Pumps and motors shall be shipped and stored per these Specifications and the manufacturer's recommendation.

1.07 WARRANTY

A. Guarantee: The equipment supplier shall furnish a warranty for all equipment provided by the equipment supplier for a period of 5 years from date of Owner's final inspection and acceptance but not longer than 66 months from date of equipment delivery. All equipment shall be guaranteed against defects in material and workmanship to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the Owner.

B. A full parts and service warranty shall be provided on all installed equipment and components for a period of 2 year(s) after written notice of start-up acceptance by the Engineer. Additional limited warranty shall be provided for an additional period of 4 years.

C. Vendor shall warrant the equipment and motors furnished under this specification for a period of 1 year against defects in materials and workmanship and operational failure.

1. In the event of failure of any part or parts of the equipment and motors during the first 1 year of service, provided that the equipment and motor has been operated and maintained in accordance with good practice, the Vendor shall furnish, deliver and install a replacement for the defective part or parts at the Vendor's own expense. Vendor is also responsible for pump and/or motor removal, reinstallation and freight.

2. The first 1 year of service shall be interpreted as the 12 month period following the installation, adjusting and acceptance testing, and the start of actual operation of the equipment, or 24 months after delivery, whichever occurs first.

3. For the 1 year warranty, the OWNER and Vendor shall together perform an equipment evaluation on each unit during the eleventh month of the warranty. This shall be a complete electrical, mechanical, and hydraulic evaluation of the motor and pump. The Vendor's cost for the equipment evaluations shall be included in the price under this contract, and the coordination and scheduling of the annual equipment evaluation shall be the responsibility of the Vendor. A detailed report will be produced by the Vendor after the evaluation describing the tests, data collected, and issues identified.

2.00 PRODUCTS

2.01 SUBMERSIBLE PUMP

A. Pump with fabricated weldments will not be acceptable.

B. All mating surfaces where water-tight sealing is required shall be machined and fitted with O-rings. Metal-to-metal sealing is acceptable at the pump to discharge elbow connection.

C. Each pump, motor, and cable assembly shall be furnished in one integral unit, factory assembled by the Pump Manufacturer. Pump shall be listed as explosion proof by Underwriter Laboratories (U.L.) or by C.S.A.

D. The pump design shall be such that the pumping unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection. The discharge connection shall be permanently installed in the wet well. The pump shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be disconnected. The guide mechanism shall be a non-sparking design and U.L. or C.S.A. listed. Connection and disconnection of the pumping unit from the discharge piping shall not require personnel to enter the wetwell. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pump unit.

E. The pump assembly shall also be capable of running dry or partially submerged for extended periods without any damage to the pump, motor, seals, or accessories.

F. Major parts, such as the stator casing, oil casing, sliding bracket, volute, impeller, and base coupling shall be constructed of cast iron or bronze. Surfaces coming into contact with the

pumped liquid shall be protected by a factory-applied epoxy coating or shall be stainless steel. External bolts, nuts, and fastening hardware shall be a minimum 300 series stainless steel.

2.02 PUMP CONSTRUCTION

A. Pump Volute

1. The pump volute shall be constructed of cast iron. A wear ring shall be provided in the volute which is constructed of 400 series hardened stainless steel or hardened ASTM A532 IIIA with a minimum Brinell hardness of 300.

B. Impeller:

1. Impellers shall be of cast stainless steel, ASTM A351 CF8M or ASTM A352 CA6NM Class B containing 13% chrome and 4% nickel or hard iron, ASTM A532 IIIA.
2. Impeller shall be factory balanced, statically and dynamically, and have long throughlets without acute turns.
3. Impellers shall be capable of withstanding wear from sediment.
4. The impeller shall be of the enclosed, non-clogging, dynamically balanced, one-, two- or three-vane design capable of passing 3-inch diameter spherical solids. The impeller shall have a slip fit onto the motor shaft and drive key and shall be fastened using the manufacturer's standard technique.

C. Wear Rings

1. Enclosed impellers' eye shall be fitted with renewable wear rings at the running joint with the bowl. Rings shall be securely attached or dowelled to prevent rotation in their seats.
2. Impellers shall be machined to the exact contour of the casing surface.
3. Casings for enclosed impellers shall be fitted with renewable wear rings at the running joint with the impeller eye. Rings shall be securely attached or dowelled to prevent rotation in their seats.
4. The impeller wear ring shall be 304 stainless steel, with a minimum Brinell hardness of 200.

D. Shaft

1. The pump shaft shall be stainless steel, ASTM A-276, Type 420 or 416, or stainless steel ASTM A-431. Carbon steel shafts or shafts with sleeves of any type are not acceptable.
2. The shaft shall be one piece construction, solid and continuous, without joints or stubs attached. Couplings will not be allowed.
3. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. Size the shaft to transmit the full driver output with a maximum deflection of 0.002-inches at the lower mechanical seal. Shaft overhang shall not exceed 2.5 times the shaft diameter.

E. Mechanical Seals:

1. Provide a tandem mechanical shaft seal system consisting of two independent seal assemblies with an oil-filled reservoir between the seals. Both seals shall be leakage free and capable of clockwise or counterclockwise rotation.
2. The upper seal shall isolate the oil reservoir from the motor.
3. The lower seal shall be independent of the impeller hub and shall isolate the oil reservoir from the pumped water.
4. The seals shall require no routine inspection, adjustment, or maintenance, but shall be easily replaced with non-proprietary seals available from manufacturers other than the original manufacturer. Seals shall not be damaged when the pump is run dry.
5. Surfaces shall be silicon carbide or tungsten carbide.
6. The entire seal shall be mounted within the oil chamber. The oil reservoir shall have a drain and inspection plug, with a positive anti-leak seal, that is easily accessible on the external of the pump. The oil reservoir shall be designed to prevent overfilling and allow room for oil to expand.
7. The oil shall be environmentally safe and suitable for use in potable water systems.
8. The seals shall not rely upon the pumped water for lubrication.
9. The following seal types are not acceptable: seals without positively driven rotating members, conventional double mechanic seals containing either a common single or double spring acting between the upper and lower seal faces, or cartridge type seals.

F. O-Rings and Fasteners:

1. All mating surfaces of the pump and motor shall be machined and fitted with nitrile rubber O-rings where watertight sealing is required. Sealing shall be accomplished by the proper fitting of the parts and not be compression or special torque requirements. All external screws and fasteners shall be made of 316 stainless steel and installed with washers and anti-seize compound.

G. Bearings

1. The pump/motor shaft shall rotate on no fewer than two bearings sized for the anticipated radial loading. One of the bearings shall also be sized for all thrust loads.
2. Bearings shall be permanently greased.
3. The impeller and motor shaft for each pump shall be designed by the manufacturer for minimum 50,000-hour AFBMA B10 bearing life under the design conditions.

H. Spare Parts

1. One set of spare parts shall be provided as follows. A set shall be provided for each size of pump.
    a. One complete set of bearings.
    b. One complete set of bowl wear rings.
    c. One complete set of impeller wear rings.

d. One complete set of gaskets and O-rings.

2.03 MOTOR AND CABLE

A. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.

1. Motor shall be rated inverter duty for operation on a variable frequency drive (VFD) with speeds from 60 percent to 100 percent of the rated synchronous motor speed and shall comply with NEMA MG-1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The Motor Manufacturer shall provide a letter certifying that the motor is compatible with the VFD. The Motor Manufacturer shall confirm that operation in low-speed ranges is acceptable or shall provide supplemental lubrication and motor cooling as necessary to allow operation in the low speed ranges.

2. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) and capable of up to 10 evenly spaced starts per hour.

3. The rotor bars and short circuit rings shall be made of cast aluminum.

4. Thermal and moisture protection shall be provided.

5. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. A signal shall be provided if there is water intrusion.

6. The use of wire nuts or crimp-type connectors is not acceptable.

B. The combined service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

C. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach an externally mounted junction box located at the pump station floor without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight Integrity to a depth of 65 feet or greater.

D. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

E. Motor shall be rated at 460 volts, 3-phase, 60 hertz.

F. The locked rotor KVA/HP shall not exceed NEMA Code Letter G, 6.29 KVA/HP.

G. Motor shall be capable of bringing the pumps up to speed with 80% of rated voltage.

H. Motor efficiency shall not be less than 90.5% when operating at maximum speed, full load, and rated voltage and frequency.

I. Pump and motor manufacturers shall provide the pump/motor leak detection and temperature sensing devices and any other devices required for pump/motor protection to the Motor Controller supplier to be mounted in the Motor Controller at the Motor Controller factory. The Motor Controller will not be shipped from the factory until the protective devices are installed.

J. The motor shaft shall be 400 series stainless steel.

K. Lead wires shall be suitable for operation in oil. The motor shall be provided with Klixon motor thermal switches embedded in the windings to protect the motor from burnout due to excessive heating. Inrush on starting shall be no more than allowed by NEC Code Letter F for motors 50 HP and larger, and no more than allowed by NEC Code Letter G for motors less than 50 HP. Each motor shall be U.L. or C.S.A. listed.

L. The electrical cable entrance to the motor shall be provided with positive strain relief to prevent leakage or pullout of the cable in the event that a force is accidentally placed on the cable during the raising or lowering of the pump. The design of cable entry shall preclude specific torque requirements to insure a watertight and submersible seal. Cable entry shall consist of a single cylindrical elastomer or Buna-N grommet, flanked by stainless steel washers all having a close tolerance fit against the cable's outside diameter and the entry inside diameter and compressed by the body containing the strain relief function separate from the function of sealing the cable. One spare set of cable seal accessories shall be provided. The entry cable system shall be warranted as described in Paragraph 1.07, Warranty.

M. Wire leads entering the junction box chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Alternately, the junction box chamber shall be sealed from the motor with a poured epoxy seal with bared conductor to prevent wicking. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Sufficient cable shall be supplied to extend from the motors to the pump control without splicing. Each pump shall be equipped with adequate cable to be routed from the termination junction box to the pump without any splices at a minimum. The power cable shall be sized according to NEC and ICEA standards and also meet P122-MSHA approval and this classification shall be embossed on the cable. The cable entry junction chamber shall be isolated from the motor by a terminal board.

N. The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression seals (O-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board each with an individual O-ring to prevent liquid passage.

O. The motor, cable, and electrical controls shall be sized, furnished, and installed so that the motor shall never exceed the nameplate rating at any point on the pumping curve.

P. Provide stainless steel cable strain relief on each cable at wet well roof slabs.

2.04 BEARINGS

A. The pump shaft shall rotate on a minimum of two grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearing(s) shall consist of at least one roller bearing for radial forces and one angular contact ball bearing for axial thrust. The minimum L10 bearing life shall be 50,000 hours at any point along the usable portion of the pump curve at maximum product speed.

2.05 DISCHARGE ELBOW AND GUIDERAIL BASE

A. A discharge elbow and guiderail base shall be provided for each pump and shall be permanently installed in the wetwell. 316 stainless steel anchor bolts embedded in concrete in accordance with pump manufacturer's layout and recommendations shall secure these connections.

2.06 GUIDERAIL AND LIFTING CHAIN

A. The guiderails and lifting chain positive recovery system shall be sized by the pump supplier. Guiderails and lifting chains shall be constructed of stainless steel. Intermediate and upper guiderail brackets shall be provided by the pump supplier to achieve the arrangement shown on the Plans.

B. The slide rails shall be continuous stainless steel designed to resist corrosion in raw water applications. Any joints in the rails shall be reinforced from within if pipe is used; continuously full-depth welded, ground smooth, and treated to resist corrosion. If pipe is used, it shall be minimum Schedule 40. The rail system shall be of adequate length to extend from the lower guide holders on the pump discharge connection to 6 inches below the top of the wet well. The system shall be mounted with stainless steel hardware. Wire slide rails are not permitted.

C. The rail support system shall be furnished by the Pump Manufacturer, to adequately support the guide (slide) rails. Intermediate guide rail supports shall be used every 12 to 15 feet or as recommended by the pump manufacturer. The system shall be mounted with stainless steel hardware.

D. Each pump shall be fitted with a stainless steel chain or cable of adequate strength and length to permit raising and lowering the pump for inspection or removal. The chain or cable shall be long enough to extend from the pump in its operating position to 4 inches above the top of the wet well. Furnish and install a stainless steel hook at the top of the wet well to hold the chain when the pump is in service.

E. Each pump shall be fitted with 3 feet of stainless steel chain of adequate strength to permit raising and lowering of the pump, and an adequate length of 1/4-inch diameter nylon rope or 18-inch stainless steel rope. The pump supplier shall provide a grip eye, which when lowered into position over the nylon rope, will automatically attach to the chain for lifting and automatically release the chain after lowering the pump back into position. The grip eye, pump chain, and associated hardware shall have a minimum capacity of 1-1/2 times the pump weight.

F. An ASTM 316 stainless steel cable system as designed and manufactured by the pump manufacturer may be utilized in place of the slide rail removal system if the cable system is

the standard used by the pump manufacturer and there are adequate number of installations using this type system as required in Paragraph 1.02B.

2.07 SLIDING COUPLING SYSTEM

A. A sliding guide bracket shall be an integral part of the pumping unit or securely attached thereto. The guide bracket shall be designed such that no strain is placed on the pump or guide rails. The volute casing shall have a machined discharge flange to automatically and firmly connect with the discharge connection, which when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. Discharge base elbow and base plate shall be supplied by the Pump Manufacturer.

B. The pump sliding coupling system shall be designed so that the downward force of the machined mating flanges shall shear away rags, hair, or other debris that would prevent a uniform watertight seal. No portion of the pump unit shall bear directly on the floor of the wet well. The pump body and slide coupling mating faces shall be bronze against cast iron.

2.08 ACCESS DOOR HATCHWAYS

A. The access door hatchway shall be provided by the pump manufacturer and shall be as specified in Section 08 31 19 “Floor Access Doors. The pump manufacturer shall verify that the proposed pumps will fit through the door opening and that the location of the doors will allow easy removal of each pump. The Contractor shall provide the size doors specified if adequate or the size required if a larger size is required to remove the pumps from the wet well. The access cover shall be provided with open assist-slow closure device and hold open device. Provide hasp and staple or other means for locking.

2.09 SAFETY GRATE

A. The safety grate shall be designed to withstand a minimum live load of 300 pounds per square foot using 17,300 psi as the design stress for the aluminum. Deflection shall not exceed 1/150th of the span. Each safety grate shall be designed to combine covering of the opening, fall through protection per OSHA standard 1910.23 and controlled confine space entry per OSHA standard 1910.146.

B. Safety grate shall be as manufactured for Halliday, USB Fab, Flygt Corporation or approved equal.

C. The safety grate shall be made of 6061-T6 aluminum and designed per the “Specifications for Aluminum Structures”, by the Aluminum Association, Inc., 5th Edition, Dec. 1986 for “Bridge Type Structures.” This specification requires the manufacturer to use 38,000 psi as the ultimate strength and 35,000 psi as the minimum yield strength, for grade 6061-T6 aluminum and then a safety factor of 2.2 be applied, leaving a 17,300 psi design stress.

D. Grate openings shall allow for visual inspection, limited maintenance and float adjustments while the safety grate fall through protection is left in place.

E. Grating design shall provide an opening for the pump power cable once the pump is pulled. This design allows the safety grate(s) to be closed after the pump is pulled, while leaving a space for the power cable.

F. Design must assure that the fall through protection is in place before the doors can be closed.

G. Each grate shall be provided with a permanent hinging system, which will lock the grate in the 90-degree position once opened.

H. Each grate shall have an opening arm, which will allow opening of the grate, while providing the grate as a barrier between the operator and the pit. The opening arm shall also be equipped with a controlled confined space entry lock (lock provided by Owner). This locking device will prevent unauthorized entry to the confined space. The grating system will allow anyone to make visual inspection and float adjustments without entering the confined space.

I. Each aluminum safety grate shall be coated with a safety orange color, promoting visual awareness of the hazard. Powder coat system shall be applied by the electrostatic spray process. The coating is a thermosetting, powder coat finish with a minimum thickness of 2 to 4 mils and shall be baked at 350 to 375 F, or as recommended by the manufacturer, until cured.

J. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.

K. All mounting hardware, bolts, nuts, etc. shall be 316 stainless steel.

2.10 PUMP MONITORS

A. Each pump shall be shipped with a pump monitoring system to monitor and display pump statuses. The following components will be provided:

1. Pump Sensor Module: Integral to pump, accepts all pump and motor sensors. Installed by pump manufacturer.

2. Base Pump Monitor: Connected to the Pump Sensor Module, located in associated pump VFD.

    a. Base unit shall be rated for 50C ambient at 90% humidity.

    b. Base unit shall have integral 24VDC power supply, with two dry contact programmable relays, one for alarm and one for shutdown.

3. Central Pump Unit: Communicates over data highway with each Base Pump Monitor. Central Pump Unit will be located in the RTU Cabinet in the electrical building.

    a. Central Pump Unit shall communicate Modbus TCP to Central SCADA system.

B. The pump monitor shall have the capability to communicate with SCADA using Modbus TCP/IP Ethernet. Associate signals shall be monitored as follows-

1. Thermal contacts or thermistors for stator winding temperature monitoring

2. Leakage sensor in the stator housing

3. Leakage sensor in the junction box

4. Leakage sensor in the oil inspection chamber

5. One or three Pt100 sensors to measure the stator winding temperature

6. Pt100 sensor to measure the main bearing temperature
7. Pt100 sensor to measure the support bearing temperature
8. Current transformer for pump current and speed measurement
9. Vibration sensor for 3-axis vibration measurement, integrated in the pump electronic module

3.00 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the Manufacturer's instructions. The Contractor will install the pumping units under the supervision and guidance of the Equipment Manufacturer's representative. Any modification to the structure as a result of requiring different size access door hatchways is the responsibility of the Contractor.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of the equipment, an acceptance test to verify the satisfactory operation of each unit shall be conducted. The Contractor shall provide the services of authorized representative to conduct all field tests. The test shall be conducted in a manner approved by and in the presence of the Engineer. The unit shall be checked for excessive noise, vibration, alignment, general operation, ease of removal, etc. All automatic and manual controls shall be tested to verify that they function in accordance with the requirements. Verify that drive equipment operates without being overloaded. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

B. The Equipment Manufacturer shall perform acceptance tests over a period of not less than two ten (10) hour tests or one twenty-four (24) hour test, or as modified by the Owner or Owner's Representative.

C. Each pump, motor, and VFD shall be tested in the field at the maximum, two intermediate, and the minimum speed. The minimum speed shall be defined as that which achieves zero flow. The intermediate speeds shall be evenly spaced between the maximum and minimum speeds. Flow shall be measured with the job flow meters as shown on plans.

D. Test Data

1. The pumping units shall be operated throughout their full range of operating heads and operating speeds, if possible, recording pump speed, pump discharge pressure, water level, flow, motor voltage and current, power factor, deflection, and motor bearing temperatures, as applicable.
2. Following completion of field performance tests, the Equipment Manufacturer shall furnish to the Engineer for review and approval certified copies of all test data and test curves for each pump.
3. Calibrated testing equipment shall be provided by the Equipment Manufacturer to measure setting, alignment, speed, and temperature of the pump.

4. Pumping units must meet the minimum performance requirements specified herein and by the Hydraulic Institute.

3.03 PAINTING

A. Pumps, motors, baseplates, discharge elbows, and guiderails shall be painted in accordance with Section 09 96 00.01 “High-Performance Coatings” of these Specifications.

3.04 SCHEDULES

	Location No. 1
Location	Colliers RWPS
Equipment No.	RWP-0101, -0102, -0103, & -0104
Number of Units	4
Rated Capacity (gpm)	10,417
Rated Head, TDH (ft.)	80
Minimum Capacity (gpm)	6,250
Min. Cap. Rated Head, TDH (ft.)	29
Minimum Shutoff Head (ft.)	108
Maximum Speed (rpm)	895
Minimum Pump Speed (rpm)	50-60 percent of max. speed
Maximum Motor HP	385
Minimum Pump Efficiency at design point	82.4
Normal Operating Head Range (ft.)	32 to 80
Minimum diameter of test sphere (in.)	3
Maximum NPSHR at design point (ft.)	14
Maximum Motor pole number	10
Minimum Rated (FL) Power Factor (1/2 load) (percent)	68
Minimum pump discharge size (in.)	16.0

END OF SECTION

ATTACHMENT A

SUBMITTAL DATA SHEET

Submit the following data with Shop Drawings for each size of Pumping Unit:

Submersible Pumps

Colliers RWPS		
Item No.	**Description**	**RWP-0101, RWP-0102, RWP-0103, & RWP-0104**
1	Make and Type Design	
2	Rated Speed	
3	Casing Material	
4	Impeller Diameter and Material	
5	Max. Impeller Diameter for Casing	
6	Diameter of Suction Flange	
7	Diameter of Discharge Flange	
8	Shutoff Head	
9	Diameter of Shaft at Impeller	
10	Maximum Brake Horsepower	
11	NPSH Required at Rated Head	
12	NPSH Required at Minimum Head	
13	Suction Specific Speed	
14	Specific Speed	

Motor Data

Item No.	Description	RWP-0101, RWP-0102, RWP-0103, & RWP-0104
1	Rated Brake Horsepower	
2	Rated Full Load Speed	
3	Full Load Efficiency	
4	3/4 Load Efficiency	
5	Full Load Power Factor	
6	3/4 Load Power Factor	
7	Maximum Thrust Rating	
8	Locked Rotor KVA	
9	Frame Size	

10	Enclosure Type	
11	Locked Rotor Amperes (LRA) at rated voltage	
12	NEMA Starting Code Letter	

Weight

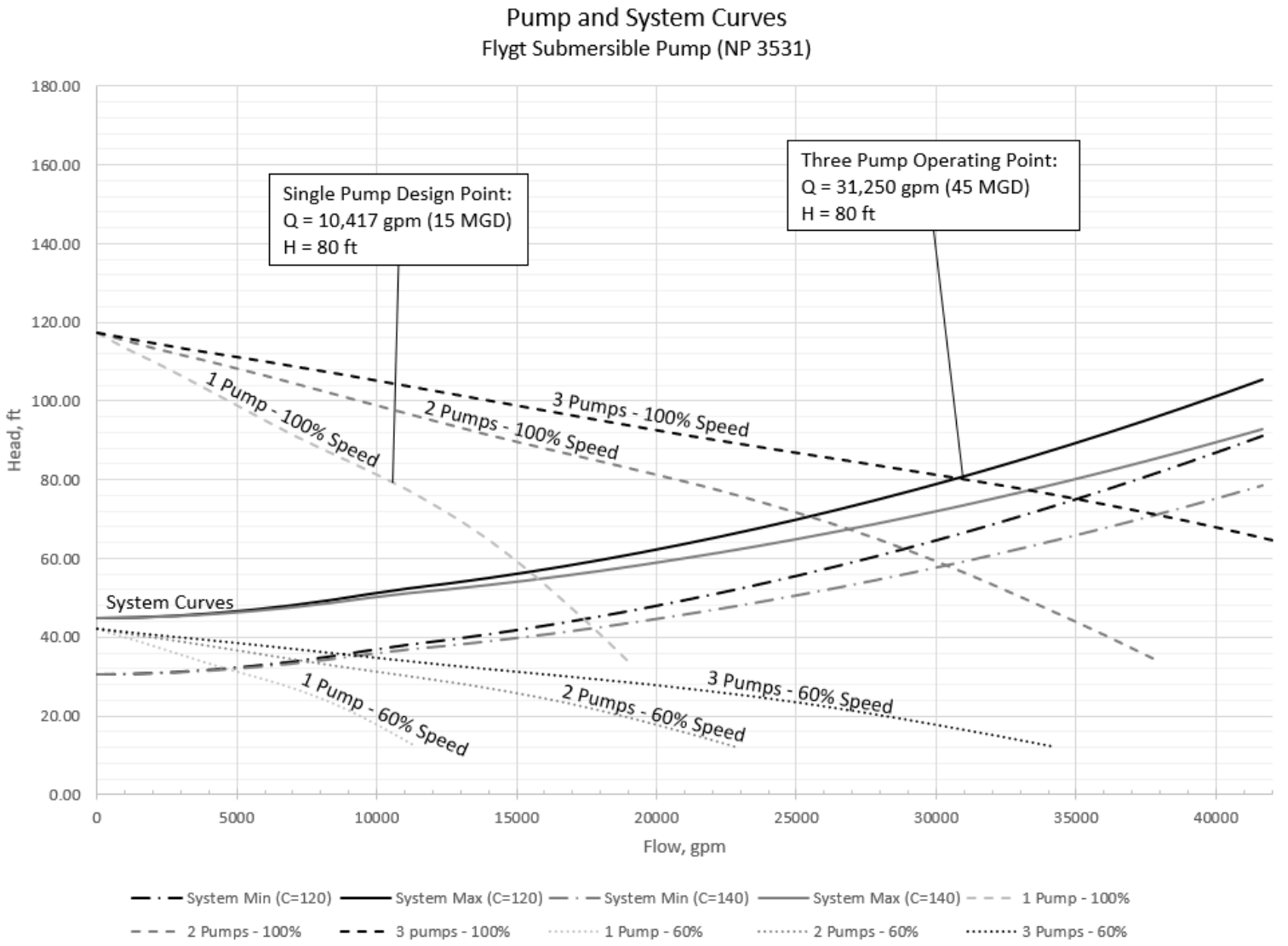
Item No.	Description	
1	Complete Pumping Unit	

Adjustable Frequency Drive

Item No.	Description	
1	Manufacturer	
2	Model	
3	Dimensions (L x W x H)	
4	Horsepower Rating	
5	Amperage Rating	
6	Voltage Rating	

END OF ATTACHMENT

ATTACHMENT B



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