



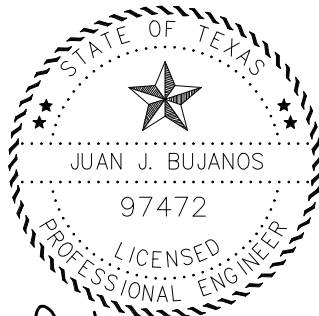
B R O W N S V I L L E
PUBLIC UTILITIES BOARD

PROJECT MANUAL
Contract Documents
&
Technical Specifications

For

SOUTHMOST REGIONAL WATER AUTHORITY
TRANSFER PUMP NO.3:

Bid No.: B005-20



JJB 11/20/19

DATE: November 20,2019

Bid Due: December 11,2019 5:00 PM
Bid Opening: December 12,2019 11:00 AM

SET No. _____

TABLE OF CONTENTS

**PART I - BROWNSVILLE PUBLIC UTILITIES BOARD CONTRACT SPECIFICATION
DIVISION 0 – BIDDING REQUIREMENTS, FORMS OF CONTRACT, BOND AND
PROPOSAL**

DESCRIPTION	PAGE No
LEGAL NOTICE AND INVITATION TO BID	1
INSTRUCTIONS TO BIDDERS	3
 BIDDING DOCUMENTS	
BID AND BID SCHEDULE	26
BID BOND	32
CONTRACTOR’S PRE-BID DISCLOSURE STATEMENT	34
SUBCONTRACTOR’S PRE-BID DISCLOSURE STATEMENT.....	38
 CONTRACT / SAMPLE FORMS	
NOTICE OF AWARD	42
ACCEPTANCE OF NOTICE	43
NOTICE TO PROCEED	44
AGREEMENT	45
PERFORMANCE BOND.....	50
PAYMENT BOND.....	53
CERTIFICATE OF INSURANCE	55
 GENERAL CONDITIONS	
GENERAL CONDITIONS	48
SUPPLEMENTARY GENERALCONDITIONS.....	108
REQUIRED FORM.....	126

PART II - TECHNICAL SPECIFICATIONS
DESCRIPTION

PAGE

DIVISION 1 - GENERAL REQUIREMENTS

01010	SUMMARY OF WORK.....	4
01019	CONTRACT CONSIDERATIONS.....	2
01025	MEASUREMENT AND PAYMENT.....	6
01039	COORDINATION AND MEETINGS.....	4
01300	SUBMITTALS.....	6
01325	CONSTRUCTION SCHEDULE.....	4
01500	TEMPORARY FACILITIES.....	6
01576	WASTE MATERIAL DISPOSAL.....	2
01610	BASIC PRODUCT REQUIREMENTS.....	4
01700	PROJECT CLOSEOUT PROCEDURES.....	2
01713	MOBILIZATION.....	2
01725	FIELD SURVEYING.....	2
01740	WARRANTIES.....	4
01785	PROJECT RECORD DOCUMENTS.....	2

DIVISION 02 - SITE CONSTRUCTION

02071	DEMOLITION AND SALVAGE OF OLD STRUCTURES.....	6
02315	EXCAVATION, TRENCHING AND BACKFILLING.....	12
02687	TESTING OF INSTALLED PIPING SYSTEMS.....	14

DIVISION 03 – CONCRETE (NOT USED)

DIVISION 04 – MASONRY (NOT USED)

DIVISION 05 – METALS

05050	ANCHORAGE & FASTENERS.....	2
050519	POST-INSTALLED CONCRETE ANCHORS.....	8

DIVISION 06 – WOODS AND PLASTICS (NOT USED)

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07902	SEALANTS.....	6
-------	---------------	---

DIVISION 08 – DOORS AND WINDOWS (NOT USED)

DIVISION 09 – FINISHES

09901	PAINTS AND COATINGS.....	12
09902	PAINTING AND PROTECTIVE COATINGS.....	18

DIVISION 10 – SPECIALTIES (NOT USED)

DIVISION 11 – EQUIPMENT

11190 MANUAL, CHECK & PROCESS VALVES..... 6
11250 VERTICAL TURBINE PUMPING UNITS46

DIVISION 12 – FURNISHINGS (NOT USED)

DIVISION 13 – SPECIAL CONSTRUCTION (NOT USED)

DIVISION 14 – CONVEYING SYSTEMS (NOT USED)

DIVISION 15 – MECHANICAL

15050 BASIC MECHANICAL MATERIALS AND METHODS.....2
15062 DUCTILE IRON PIPE AND CAST PIPE AND DUCTILE IRON FITTINGS 6
15090 PIPE SUPPORT SYSTEMS.....8
15100 GENERAL PIPING.....14
15122 PIPE COUPLING.....14

DIVISION 16 – ELECTRICAL

16000 ELECTRICAL SPECIFICATIONS19
16030 ELECTRICAL POWER SYSTEM TESTING AND COORDINATION.....6
16060 GROUNDING AND BONDING.....5
16070 HANGERS AND SUPPORTS.....6
16075 ELECTRICAL IDENTIFICATION.....6
16123 600 VOLT OR LESS WIRES AND CABLES.....14
16134 BOXES.....11
16140 WIRING DEVICES.....9
16264 VARIABLE FREQUENCY DRIVES.....17
16272 DRY TYPE TRANSFORMERS7
16285 SURGE PROTECTIVE DEVICES7
16411 DISCONNECT SWITCHES6
16444 LOW VOLTAGE MOTOR CONTROL CENTERS ,,.....13
16600 ELECTRICAL ACCEPTANCE TESTING15
16670 LIGHTNING PROTECTION7

DIVISION 17 –CONTROL SYSTEMS

17050 INSTRUMENTATION17
17720 CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS15
17721 LOCAL OPERATOR INTERFACE (LOI)8
17733 NETWORK MATERIALS AND EQUIPMENT.....9
17762 PCS SOFTWARE13

END OF SECTION

**LEGAL NOTICE
AND
INVITATION TO BID
B #005-20**

Sealed bids will be received by the PUBLIC UTILITIES BOARD of the City of Brownsville, Texas ("BPUB"), at the PUB Purchasing Department office; 1495 Robinhood Drive; Brownsville, Texas 78521 **until 5:00 PM, December 11, 2019** for the Project described in the Contract Documents and Specifications entitled:

**SOUTHMOST REGIONAL WATER AUTHORITY
TRANSFER PUMP NO. 3**

Bids received after this time will not be considered.

A Non-Mandatory Pre-Bid Conference will be held at the BPUB Purchasing Office, 1495 Robinhood Drive, Brownsville, Texas 78521 at 10:00 AM on Tuesday, December 3, 2019.

Bids will be publicly opened and read aloud on December 12, 2019 at 11:00 AM. Bidders are invited to attend the bid opening at the Brownsville PUB Purchasing Office.

Copies of the Contract Documents and Specifications may be obtained at the BPUB Purchasing Department; 1495 Robinhood Drive; Brownsville, Texas 78521 or at the following website. https://www.brownsville-pub.com/rfp_status/open/.

Each bid, in duplicate, shall be enclosed in a sealed envelope and shall be plainly marked on the outside of the envelope: **"B005-20 SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3, DECEMBER 11, 2019, 5:00 PM"**. This envelope shall be addressed to Diane Solitaire; Brownsville Public Utilities Board; Purchasing Department; 1495 Robinhood Drive; Brownsville, Texas 78521.

Each bid shall constitute an offer to the Board, as outlined therein, and shall be irrevocable for at least ninety (90) days after the time announced for the opening thereof.

Each bid shall be accompanied by a Certified or Cashier's check payable to the order of the Brownsville Public Utilities Board, City of Brownsville, Texas for a sum not less than five (5%) percent of the total amount bid. In lieu of a check, a Bid Bond may be submitted in an amount not less than five (5%) percent of the total amount bid with a Corporate Surety licensed to do business in the State of Texas, conditioned that the BIDDER will pay the BPUB, as mutually agreed to liquidated damages, and not as a penalty, the amount specified in the Bond unless he enters into a contract in accordance with his bid. BIDDER is required to execute a contract and furnish a Performance Bond, Payment Bond and a Certificate of Insurance. If the BIDDER fails to execute the contract and to furnish satisfactory Performance and Payment Bonds and Insurance Certificates within ten (10) days from the date on which he is notified that his bid has been accepted, the amount of his check or bid bond shall be forfeited to the BPUB as mutually agreed to liquidated damages, and not as a penalty.

The BPUB will not be responsible in the event that the U.S. Postal Service or any other courier system fails to deliver the sealed bids to the Brownsville Public Utilities Board, Purchasing Office by the given deadline above. **No bids will be accepted via facsimile or electronic transmission.**

The BPUB specifically reserves the right to reject any or all bids, to waive irregularities or informalities in any or all bids and to accept any bid which is deemed to be in the best interest of the Board.

Diane Solitaire
Purchasing Department
(956) 983-6366
(956) 983-6367-Fax

INSTRUCTIONS TO BIDDERS
Please submit this page upon receipt

Acknowledgment Form
SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3
B005-20

For any clarifications, please contact Diane Solitaire at the Brownsville Public Utilities Board, Purchasing Department at (956) 983-6366 or e-mail: dsolitaire@brownsville-pub.com

Please fax, mail or e-mail this page upon receipt of the bid package or legal notice. If you only received the legal notice and you want the bid package mailed, please provide a method of shipment with account number in the space designated below.

Check one:

Yes, I will be able to send a bid; obtained bid package from website.

Yes, I will be able to send a bid; please email the bid package.

Email: _____

Yes, I will be able to send a bid; please mail the bid package using the carrier & account number listed below:

Carrier: _____

Account: _____

No, I will not be able to send a bid for the following reason:

If you are unable to send your bid, kindly indicate your reason for "No bid" above and return this form **via email to:** dsolitaire@brownsville-pub.com **or fax to:** (956) 983-6367. This will ensure you remain active on our vendor list.

Date _____

Company: _____

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Phone: _____ Fax: _____

Email: _____

Special Instructions

Contract Information

- **Interpretation**

Questions concerning terms, conditions, and technical specifications should be submitted in writing to:

Diane Solitaire, Purchasing Manager
Email: dsolitaire@brownsville-pub.com

- **Tentative Time Line**

1. November 25, 2019 through December 11, 2019 – Vendor bid preparation.
2. December 11, 2019 at 5:00 PM - **Vendor must submit bid, in duplicate, sealed in an envelope to:**

Diane Solitaire, Purchasing Manager
1495 Robinhood Drive
Brownsville, TX 78521

Bid #B005-20 – SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO.
3
Due December 11, 2019 at 5:00 PM

The above noted information must be included on bid envelope and on any carrier's envelope/package. The Brownsville Public Utilities Board will not be held responsible for missing, lost or late mail. Brownsville Public Utilities Board will not accept electronic transmissions or facsimiles of sealed bids.

1. December 03, 2019 - Non-Mandatory Pre-Bid Conference at 10:00 AM
2. December 12, 2019 - Open bids at 11:00 AM
3. December 12, 2019 - December 17, 2019 - Evaluate bid
4. December 17, 2019 - Deadline to provide final recommendations for Board approval.
5. January 6, 2020 - Send to SRWA Board for formal and possible Contract award approval

- **“Or Equal”**

Brand name and/or manufacturer's references used in this Request are descriptive – not restrictive – they are intended to generally indicate type and quality desired. Brands of like nature and quality will generally be considered. If bidding on other than referenced Specifications, please provide complete descriptive information of said material/equipment article. BPUB also reserves the legal right to specify a “sole source” component if such component is critical for integration to a larger

assembly and alternative manufactured items will not meet the design and/or performance needs of the BPUB, in BPUB's sole discretion.

- **Pricing**

Bid unit prices on BPUB estimated quantities specified, extend and show total. In case of errors in extension, unit prices expressed in written words and not numerals, shall govern. Prices shall remain firm throughout the Contract.

All fields (UNIT PRICE & TOTAL PRICE) in the Bid Schedule must be filled in. The data must be complete to identify any bidding brand called for specifically.

Failure to submit any of the above information with the sealed bid may disqualify bid as non-responsive.

- **Contractor Representative**

The successful contractor agrees to send a personal representative with binding authority for the company to the Brownsville Public Utilities Board, upon request, to make any minor clarifications or adjustments and/or assist with coordination of all transactions as needed to allow Contract entry.

- **Quality of Products**

All material and equipment items specified must be new, in first class condition, including containers suitable for shipment and storage. No substitutions in standard grades or lesser quality will be accepted.

- **Determining Factors for Award**

1. Price
2. Responsibility of contractor to perform the intended work and responsiveness to the bid request.
3. Compliance with requirements of the technical specifications
4. Quality of performance on previous work on similar contracts
5. Recent successful completion of similar projects
6. BPUB financial and legal responsibility evaluations of any identified teaming arrangements involving significant joint ventures, subcontractors, and suppliers.
7. Safety record will be considered when determining the responsibility of the bidder

- **Contract with Vendor/Entity Indebted to BPUB**

It is a policy of the BPUB to refuse to enter into a contract or other transaction with an individual, sole proprietorship, joint venture, Limited Liability Company or other entity indebted to BPUB.

- **Vendor ACH (Direct Deposit) Services**

The BPUB has implemented a payment service for vendors/contractors by depositing the contract payment directly to the contractor's/vendor's bank account. Successful vendor(s)/contractors will be required to receive payments directly through Automated Clearing House (ACH) in lieu of a paper check. **Return the Direct Deposit Authorization Form with the bid response. Vendor must agree to receive payment via ACH (Direct Deposit).**

- **Tax Identification Number (TIN)**

In accordance with IRS Publication 1220, aW9 form, or a W8 form in cases of a foreign vendor, will be required of all vendors doing business with the Brownsville PUB. If a W9 or W8 form is not made available to Brownsville PUB, the first payment will be subject to income tax withholding at a rate of 28% or 30% depending on the U.S. status and the source of income as per IRS Publication 1220. **The W9 or W8 form must be included with bid response.** Attached are sample forms.

- **Taxes**

The City of Brownsville and its Brownsville Public Utilities Board are exempt from Federal Excise Tax, State Tax and local sales Taxes. Do not include any taxes in the bid proposal. If it is later determined that tax was included in the bid it will not be included in the tabulation or any awards. Tax exemption certificates will be furnished by BPUB upon request.

- **Signing of Bid**

Failure to manually sign bid will disqualify it. Person signing bid should show title or authority to bind their firm to a contract.

- **EEOC Guidelines**

During the performance of this contract, the contractor agrees not to discriminate against any employee or applicant for employment because of race, national origin, age, religion, gender, sexual preference, marital or veteran status, or physically challenging condition.

- **Living Wage Statement**

On April 16, 2007, the BPUB Board of Directors approved a local "living wage" policy that requires all Contractors and Subcontractors performing 100% Non-Federally funded Work for the BPUB to pay a minimum wage rate of \$8.00/hour. The BPUB-requires that all Contractors and Subcontractors comply with this policy. Otherwise, the BPUB adopts the Federal Department of Labor Wage scales for Cameron County on 100% Non-Federally funded projects as specified later herein in the Supplementary General Conditions.

- **Contract and Purchase Order**

The services shall be completed in a timely manner as specified in specifications. A contract for the services will be placed into effect by means of a purchase order issued by the Brownsville Public Utilities Board after tabulation and final Contract approval by the Board.

- **Brownsville Public Utilities Board Rights**

1. If only one or no bid is received by "submission date", the BPUB has the right to reject, re-bid, accept and/or extend the bid by up to an additional two (2) weeks from original submission date.
2. The right to reject any/or all bids and to make award as it may appear to be advantageous to the Brownsville Public Utilities Board.
3. The right to hold bid for 90 days from submission date without action, and to waive all informalities in any bid.
4. The right to extend the total bid beyond the original 90-day period prior to an award, if agreed upon in writing by all parties (BPUB and vendor/contractor) and if bidder/vendor holds original bid prices firm.
5. The right to terminate for cause or convenience all or any part of the unfinished portion of the Project resulting from this solicitation within THIRTY (30) calendar days written notice; for cause: upon default by the vendor/contractor, for delay or non-performance by the vendor/contractor; or if it is deemed in the best interest of the BPUB for BPUB's convenience.

- **Corrections**

Any interpretation, correction, or change of the Invitation to Bid will be made by written ADDENDUM. Changes or corrections will be issued by the Brownsville PUB Purchasing Department. **Addenda will be faxed to all who have returned the bid acknowledgment form.** Addenda will be issued as expeditiously as possible. It is the responsibility of the vendors/contractors to determine whether all Addenda have been received. It will be the responsibility of all respondents to contact the Brownsville PUB prior to submitting a response to the Invitation to Bid to ascertain if any/all Addenda have been issued, and to obtain any all Addenda, execute them, and return Addenda with the response to the Invitation to Bid. Addenda may also be posted on BPUB's website.

1. RECEIPT AND OPENING OF BIDS:

The Brownsville Public Utilities Board, City of Brownsville, Texas (hereinafter called OWNER), invites bids on the form attached hereto, all blanks of which must be appropriately filled in, in ink, for Project entitled "SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3".

The OWNER may consider informal and non-responsive, any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn by vendor/contractor prior to the above scheduled time for the opening

of bids or OWNER authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No BIDDER may withdraw a bid within at least ninety (90) days after the actual date of the opening thereof.

2. INSPECTION OF SITE:

Each BIDDER shall visit the Project site of the proposed work and fully acquaint himself with the existing conditions there relating to construction and labor, and shall fully inform himself as to the facility involved, the difficulties and restrictions attending the performance of the Contract. The BIDDER shall thoroughly examine and familiarize himself with the Drawings, Technical Specifications, and all other Contract Documents. The Contractor, by the execution of the Contract, shall in no way be relieved of any obligation under it due to his failure to receive or examine any form or legal instrument, or to visit the Project site and acquaint himself with the conditions there existing and the OWNER will be justified in rejecting any claim for extra time, or compensation, or both, based on facts regarding which Contractor should have been on notice as a result of such a diligent Project site visitation. Visits to the Project site shall be arranged by calling Joe Saldivar, Jr., W/WW Operator Chief, with the Southmost Regional Water Authority at telephone no. (956) 983-6486.

3. PREPARATION OF BID AND USE OF SEPARATE BID FORMS:

These Contract Documents include a complete set of bidding documents. The BIDDER shall copy all Documents listed in the table of contents under the heading BIDDING DOCUMENTS and shall submit two sets (original signed and one signed photocopy) of his bid on these forms. A bid shall be comprised of the BIDDING DOCUMENTS completed by the BIDDER plus supplemental information required by the Specifications and Contract Documents.

If any of the information submitted as part of the bid is considered to be proprietary by the BIDDER, he shall conspicuously identify such intended confidential information in his bid. BPUB is subject to the provisions of the Texas Public Information Act and cannot legally guarantee confidentiality of submittals and may need to consult with its legal counsel and the Texas Attorney General in rendering decisions on any requested disclosures.

- a) Preparation. Each bid shall be carefully prepared using the bid and bid data forms included as a part of the bidding documents. Entries on the bid and bid data forms shall be typed, using dark black ribbon, or legibly written in black ink. All prices shall be stated in written words and numeric figures, except where the forms provide for figures only. In case of discrepancy, especially in any sum total extensions, the amount shown in written words will generally prevail over numeric unit prices.

The BIDDER shall acknowledge, in the space provided in the bid form, receipt of each Addendum issued for the Specifications and Documents during the bidding period.

The BIDDER shall assemble all drawings, catalog data, and other supplementary information necessary to thoroughly describe work, materials and equipment covered by the bid, and shall attach such supplemental information to the copies of the specifications and documents submitted.

- b) Signatures. Each BIDDER shall sign the bid with his usual signature and shall give his full business address. The BIDDER's name stated on the bid shall be the exact legal name of the firm. The names of all persons signing should also be typed or printed below the signature.

Bids by partnerships shall be signed with the partnership name followed by the signature and designation of one of the partners or other authorized representative. A complete list of the partners shall be included with the bid.

Bids by a corporation shall be signed in the official corporate name of the corporation, followed by the signature and designation of the "president," "secretary," or other appropriate person authorized to bind the corporation.

A bid by a person who affixes to his signature the word "president," "secretary," "agent," or other designation, without disclosing his principal, will be rejected. Satisfactory evidence of the authority of the officer signing on behalf of the corporation shall be furnished. Bidding corporations shall designate the state in which they are incorporated and the address of their principal office.

- c) Submittal. The original signed bid (and its accompanying photocopy) shall be transmitted to arrive at the designated BPUB address not later than the date and time stipulated in the Legal Notice and Invitation to Bid.

Submit the original signed bid (and its accompanying photocopy) to:

Brownsville Public Utilities Board of the
City of Brownsville, Texas
1495 Robinhood Drive
Brownsville, Texas 78521

Attention: Ms. Diane Solitaire
Purchasing Department

Each bid must be submitted in duplicate as stated above (original signature and photocopy), in a sealed envelope bearing on the outside the name of the BIDDER, his address, and the name of the Project for which the bid is submitted. If forwarded by mail, the sealed envelope containing the bid itself must be enclosed in another mailing envelope addressed as specified in the bid form.

4. METHOD OF BIDDING: UNIT PRICE, AND LUMP SUM.

Prices shall be firm, not subject to qualification, condition or adjustment. Prices shall be in United

States dollars. Prices shall be lump sum, except where unit prices are requested by the bid forms. When unit price items are required by the bid, the unit prices for each of the several items in the bid of each BIDDER shall include its pro-rata share of overhead, so that the sum of the products obtained by multiplying the quantity shown for each item, by the unit price bid, represents the total bid. Any bid not conforming to that requirement may be rejected as informal and non-responsive. The special attention of all BIDDERS is called to this provision, for should conditions make it necessary to revise the quantities, no limit will be fixed for such increased or decreased quantities nor extra compensation allowed, provided the net monetary value of all such additive and subtractive changes in quantities of such items of work pursuant to public competitive bidding statutes (i.e., difference in cost) shall not cumulatively increase or decrease the original Contract price by more than twenty-five (25%) percent. A proposed decrease only that exceeds twenty-five (25%) percent of the original Contract price must be agreed to in advance by the Contractor.

5. DISCLOSURE BY BIDDER:

Each BIDDER shall submit with the bid documents, on the form furnished for that purpose, his Pre-Bid Disclosure Statement showing his experience record in performing the type of work embraced in the contract, his organization and equipment available for the work contemplated, and, when specifically requested by the OWNER, a detailed financial statement. The OWNER shall have the right to take such steps as it deems necessary, including telephonic contact to other owner references, to determine the ability and responsibility of the BIDDER to perform his obligations under the Contract and the BIDDER shall be responsive in furnishing the OWNER all such information and data for this purpose as it may request. OWNER reserves the right to reject any bid where an investigation of the available evidence or information does not satisfy the OWNER that the BIDDER is responsible to properly carry out the terms of the Contract. This shall also apply to any proposed subcontractor(s).

6. SUBCONTRACTS:

The BIDDER is specifically advised that any person, firm, or other party to whom it is proposed to award a subcontract under this contract must be acceptable to the OWNER, and that a Pre-Bid Disclosure Statement for each proposed subcontractor must also be submitted with the bid documents.

7. BID SECURITY:

Each bid must be accompanied by a certified or cashier's check, or a bid bond prepared on the form of the bid bond attached hereto, duly executed by the BIDDER as principal, and having as surety therein a surety company approved by the OWNER, and authorized to do business in the State of Texas, in the amount of not less than five (5%) percent of the total bid amount, but not less than \$2,500.00. Such checks, or bid bonds will be returned to all except the three lowest BIDDERS within fifteen (15) days after the opening of bids, and the remaining checks, or bid bonds will be returned promptly after the OWNER and the accepted successful BIDDER have executed the Contract or if no award has been made, within Ninety (90) calendar days after the date of the opening of bids. The bid security will be returned upon demand of the BIDDER at any time thereafter, so long as he has not been notified of the acceptance of his bid.

8. ADDENDA AND INTERPRETATIONS:

No oral interpretations by OWNER and its representatives shall be binding upon OWNER as to the meaning of the Plans, Specifications, Contract Documents, or other pre-bid documents.

Any interpretation, correction, or change of the bid documents will be made by ADDENDUM only. Changes or corrections will only be issued by the Brownsville PUB Purchasing Department. Addenda will be faxed to all who have returned the bid acknowledgment form. Addenda will be issued as expeditiously as possible. It is the responsibility of the vendors/contractors to determine whether all Addenda have been received. It will be the responsibility of all respondents to contact the Brownsville PUB Purchasing Department prior to submitting a response to the bid to ascertain if any Addenda have been issued, and to obtain any all Addenda, execute them, and return Addenda with the response to the bid. All Addenda so issued shall become part of the Contract Documents.

9. FACSIMILE MODIFICATION:

Any BIDDER may modify (not originally submit) his bid by facsimile communication at any time prior to the scheduled bid closing time for receipt of bids, provided such communication is received by the OWNER, in the BPUB Purchasing Department, prior to the bid closing time, and provided further, the OWNER is satisfied that a written confirmation of the facsimile modification, over the original signature of the BIDDER, was also mailed prior to the bid closing time. The facsimile communication should not reveal the total bid price, but only should provide the clarification, addition or subtraction, or other modification, so that the final bid prices or terms intended will not be known by the OWNER, until the original sealed bid is opened and the modification computed by OWNER.

Revised bids submitted before the opening of bids, whether forwarded by mail or facsimile, if representing an increase in excess of two percent (2%) of the original bid submittal, must have the bid security (bid bond or check) adjusted accordingly; otherwise the bid will not be considered responsive.

If the written and originally signed confirmation of a bid revision is not received within three (3) calendar days after the bid closing time, no consideration will be given to any proposed adjustment contained in the facsimile modification.

10. TIME FOR RECEIVING BIDS:

Bids received prior to the advertised hour of opening will be securely kept sealed by BPUB. The officer whose duty it is to open them will decide when the specified time has arrived, and no bid received thereafter will be considered; except that when a bid arrives by mail after the time fixed for opening, but before the public reading of all other bids is completed, and it is shown to the satisfaction of the OWNER that the non-arrival on time was due solely to delay in the mails for which the BIDDER was not responsible, such bid will be received and considered.

BIDDERS are cautioned that, while facsimile modifications of bids may be received as provided

above, such modifications, if not explicit and if in any sense subject to misinterpretation, shall make the bid so modified or amended, subject to rejection for non-responsiveness.

11. OPENING OF BIDS:

At the time and place fixed for the public opening of bids, the OWNER will cause to be opened and publicly read aloud every bid received within the time set for receiving bids, irrespective of any irregularities therein. BIDDERS and other persons properly interested may be present, in person or by representative.

12. WITHDRAWAL OF BIDS:

Bids may be withdrawn on written, facsimile or electronic transmission request dispatched by the BIDDER in time for delivery in the normal course of business prior to the time fixed for bid opening; provided, that written confirmation of any facsimile withdrawal over the signature of the BIDDER is placed in the mail and postmarked prior to the time set for bid opening. The bid security of any BIDDER withdrawing the bid in accordance with the foregoing conditions will be returned promptly.

13. AWARD OF CONTRACT: REJECTION OF BIDS:

The Contract will be awarded to the responsive and responsible BIDDER submitting the lowest bid complying with the conditions of the Legal Notice and Invitation for Bids. The BIDDER to whom the award is made will be notified at the earliest possible date. The OWNER, however, reserves the right to reject any and all bids and to waive any informality in bids received, whenever such rejection or waiver is in BPUB's interest.

The OWNER reserves the right to consider as not responsible, any BIDDER who does not habitually perform with his own forces the major portions of the work involved in construction of the improvements embraced in this proposed Contract. This provision is meant to prevent wholesale assignment and "brokering" of awarded contracts.

14. EXECUTION OF AGREEMENT: PERFORMANCE AND PAYMENT BOND:

Subsequent to the Notice of Award and within ten (10) calendar days after the prescribed forms are presented for signature, the successful BIDDER shall execute and deliver to the OWNER an Agreement in the form included in the Contract Documents in such number of copies as the OWNER may require.

Having satisfied all conditions of award as set forth elsewhere in these Documents, the successful BIDDER shall, within the period specified in the preceding paragraph, furnish a Performance Bond and Payment Bond, in accordance with the following parameters:

- a.) For a Contract in excess of \$100,000.00, a Performance Bond shall be executed in the full amount of the Contract, conditioned upon the faithful and timely

performance of the Work in accordance with the Plans, Specifications, and Contract Documents. Said Bond shall be solely for the protection of the OWNER.

- b.) For a Contract in excess of \$50,000.00, a Payment Bond shall be executed in the full amount of the Contract, solely for the protection of all proper claimants supplying labor and material in the prosecution of the Work provided for in the Contract, for the use of each such claimant perfecting a proper claim. Payment Bonds are required under Texas law, since no mechanics' liens are allowed against BPUB's public property assets.

When bonds are required, they shall serve as security for the faithful performance of the Contract, and for the payment of all persons, firms or corporations to whom the Contractor may become legally indebted to for labor, materials, tools, equipment, or services of any nature, including utility and transportation services employed or used by him in performing the work. Such bonds shall be in the same form as that included in the Contract Documents and shall bear the same date as, or a date subsequent to that of the Agreement. The current power of attorney for the person who signs for any surety company shall be attached to such bonds. These bonds shall be signed by a guaranty or surety company legally authorized to do business in the State of Texas.

The failure of the successful BIDDER to execute such Agreement and to supply the required bonds and insurance certificates within ten (10) calendar days after the prescribed forms are presented for signature, or within such extended period as the OWNER may grant in writing, based upon reasons determined sufficient by the OWNER, shall constitute a default, and the OWNER may either award the contract to the next lowest responsive and responsible BIDDER, or re-advertise for bids, and may charge against the defaulting BIDDER the difference between the amount of the defaulted bid and the amount for which a final contract for the work is subsequently executed, irrespective of whether the amount thus due exceeds the amount of the bid bond. If a more favorable bid is received by re-advertising, the defaulting BIDDER shall have no claim against the OWNER for a bid bond refund.

15. LIQUIDATED DAMAGES FOR FAILURE TO ENTER INTO CONTRACT:

The successful BIDDER, upon his failure or refusal to execute and deliver the Contract, Bonds and insurance certificates required within ten (10) calendar days after he has received notice of the acceptance of his bid, shall forfeit to the OWNER, as mutually agreed to liquidated damages (and not as a penalty) for such failure or refusal, the security provided in the bid bond or otherwise deposited with his bid.

16. TIME OF COMPLETION AND LIQUIDATED DAMAGES:

BIDDER agrees by submission of his bid to commence Work on the date to be specified in a written "Notice to Proceed" issued by the OWNER and to Substantially Complete the Project within ONE HUNDRED EIGHTY (180) consecutive calendar days.

BIDDER agrees by submission of his bid to pay as mutually agreed to liquidated damages, and not as a penalty, the sum of Three Hundred Dollars (\$300.00) per calendar day for each consecutive

calendar day that the Project is not Substantially Complete beyond ONE HUNDRED EIGHTY (180) consecutive calendar days.

17. NOTICE OF SPECIAL CONDITIONS:

Attention is particularly called to those parts of the Contract Documents and Specifications which address the following:

- A. Inspection and testing of materials.
- B. Insurance requirements.
- C. Wage and Hour Provisions.
- D. State Sales and Use Tax Exemption Provisions

18. LAWS AND REGULATIONS:

The BIDDER's attention is directed to the fact that all applicable federal, State and local laws, statutes, ordinances, codes and the rules and regulations of all authorities having jurisdiction over construction of the Project shall apply to the Contract throughout, and they will be mutually deemed to be included in the Contract, the same as though herein written out in full.

19. EQUAL EMPLOYMENT OPPORTUNITY:

Attention of BIDDERS is particularly called to the requirement for ensuring that employees and applicants for employment are not discriminated against because of their race, religion, gender, sexual preference, physically challenging condition or national origin.

20. PRE-BID CONFERENCE:

A pre-bid meeting between the OWNER, prospective bidders, suppliers, etc., will be held to answer any questions concerning the Work. No Addenda will be issued at this meeting. Subsequent thereto, if necessary to clear up any written questions, a written Addendum will be issued by the OWNER to all pre-bid conference attendees. The pre-bid meeting will be held at the place, time and date indicated in the Legal Notice. Interested parties are invited to attend. Attendance at the Pre-Bid Conference is not mandatory, but is recommended for all contractors and suppliers interested in bidding the Work for the Project.

21. SUBMITTAL OF TRENCH SAFETY DESIGN: (RESERVED)

The apparent low BIDDER shall provide the OWNER with a Trench Safety System Plan and a certificate signed and sealed by a Registered Professional Engineer licensed by the State of Texas, within 21 calendar days after the date of the opening of Bids prior to award of the Contract. Failure to timely comply may disqualify BIDDER.

(Reserved)

22. INFORMATION TO BE SUBMITTED WITH BID:

Each BIDDER shall submit with his bid pertinent information concerning proposed equipment and materials and proposed construction organization.

a) **Equipment and Materials.** In addition to the information submitted on the bid and bid data forms, each BIDDER shall submit all specifications, preliminary drawings, and similar descriptive information necessary to describe completely the equipment and materials he proposes to furnish.

The bid shall be based on using new equipment and materials which comply with the Specifications and Documents in every respect, unless existing equipment is specifically noted by OWNER for reuse. If alternate or "equal" equipment and materials are indicated in the bid, it shall be understood that the OWNER will have the option of selecting any one of the alternates so indicated and such selection shall not be a cause for extra contractor compensation or extension of time. OWNER specifically reserves the legal right to specify "sole source" equipment or materials in the Specifications when unique circumstances warrant.

b) **Contractor's Field Organization.** Each BIDDER shall submit with his bid an organizational chart showing the names of field management, supervisory, and technical personnel, and the details of the management, supervisory, and technical organization which he proposes to use for this Project. The successful BIDDER's organizational concept will be subject to the review and acceptance of the OWNER. The experience record of the Contractor's field superintendent shall be submitted with the bid.

23. PREFERENCE LAW:

Bid evaluations will take into consideration any Preference Laws of the State of Texas, and any reciprocity laws of other states as they may be addressed by current Texas law.

24. SUBSURFACE GEOLOGIC CONDITIONS: (RESERVED)

Each BIDDER shall be responsible for determining prior to bidding, the types of subsurface materials which will be found in the event that any new footings and upright structural supports for the Project are required. If test borings have been made on the Project site by the BPUB or its consultants, the locations and logs of the test borings are bound as an appendix to these Specifications and Documents.

It is to be expressly understood and acknowledged by the BIDDER, that any information on subsurface geology made available by OWNER for BIDDER'S convenience shall not be a part of the Contract Documents and there is no expressed or implied guarantee of the data given, nor of the interpretation thereof.

All excavation for this Project will be unclassified and the BIDDER shall be responsible for investigating and satisfying himself of subsurface geologic conditions (including the presence or likelihood of encountering soils requiring dewatering, rock or rock-like materials) prior to submitting his bid, which shall include any and all costs BIDDER associates with avoiding, managing or removing said subsurface geologic conditions without claim for extra compensation

against OWNER.

25. DISPOSAL OF EXCESS MATERIALS:

After completion of this Project there may be in some instances an excess of spoil material or waste material left over. In such cases where there is an excess of material, BIDDER shall load and haul it away from the job site and dispose of it in a legal manner so as not to: trespass; adversely impact any protected wetlands; adversely impact the 100 year flood plain; adversely impact any endangered species; or otherwise create drainage diversions or impoundments. No extra remuneration for this Work will be allowed.

26. EROSION AND SEDIMENT CONTROL MEASURES:

The BIDDER is expected to conduct his Work in such a manner as to minimize any soil erosion or sediment runoff from the construction site. Earth cuts and fills shall have smooth, flat side slopes, as generally indicated on the PLANS, to preclude erosion of the soil. Such operations should be timed consistent with the actual need for doing the Work and only to leave raw, unprotected surfaces for a minimum of time.

Existing lawns are to remain intact as far as practical. Such areas as are disturbed shall be duly restored by the BIDDER to as good as or better than original condition using the same type of grass, shrubs, or cover as the original. The BIDDER shall be responsible for correcting any erosion that occurs at his sole cost without claim for extra compensation.

As construction progresses, and in accordance with State and federal laws regulating storm water runoff and management from construction sites greater than five acres in size, if applicable, (See: Section 405 of the Water Quality Act of 1987, Section 402(P) as amended), and at locations where erosion with sediment runoff occurs or is likely to occur, the BIDDER shall construct temporary ditches, perimeter siltation screens, retainage levees, drains, inlets, or other works to manage, prevent, or correct the possible conditions. Upon completion of the Work, such facilities shall be removed.

During construction, the BIDDER shall take the necessary precautions to see that erosion is controlled and sediment runoff is prevented so as to protect the quality of any neighboring water bodies.

27. SAFETY PROVISIONS:

BIDDER shall provide barricades, flares, warning signs, and/or flagmen so that danger and inconvenience to the OWNER, public, and any job site working personnel, will be mitigated. In addition to any other requirements of the Contract Documents, the BIDDER shall be responsible for familiarity and compliance with all Federal (OSHA), State, railroad and local safety rules, laws and requirements.

28. PROTECTION OF PROPERTY AND EXISTING UTILITIES:

Within developed areas, all public and private property along and adjacent to the BIDDER'S operations, including roads, driveways, lawns, yards, shrubs, drainage gradients, and trees, shall be adequately protected, and when damages occur, they shall be repaired, replaced, or renewed or otherwise put in a condition equal to, or better than, that which existed before the BIDDER caused the damage or removal.

An attempt has been made by BPUB to show all known existing utilities on the PLANS, but the possibility remains strong that some underground utilities may exist that have not been shown. The BIDDER, through mandatory contact with local utility owners, shall keep himself informed and take such precautions as necessary to avoid utility damage and unsafe working conditions for employees.

29. WAGES AND HOURS:

The most recent wage rate determination from the U.S. Department of Labor for Cameron County, Texas as amended within the previous three (3) years and as locally adopted by the BPUB, is a part of these Specifications and controls minimum wage, hour and any fringe benefits, with the exception that no wage shall be paid below \$8.00 as established locally by the BPUB.

A copy of the appropriate (building and/or heavy/highway) wage rate schedule(s) must be posted at the job site in both English and Spanish and kept posted in a conspicuous place on the site of the Project at all times during construction. The BIDDER shall familiarize himself with the included General Conditions Section entitled "Wage and Labor Standard Provisions - 100% Non-Federally Funded Construction." Copies of the wage rate schedule(s) are included herein, but the responsibility for initial posting and keeping same posted, rests upon the BIDDER.

30. GUARANTEE:

The BIDDER shall warranty and guarantee the Work, equipment and materials for a period of at least one (1) year after date of final acceptance in writing by the OWNER. During this period, the BIDDER shall make any repairs and/or replacements of defective equipment and materials and corrections of Work due to poor workmanship, all as may be required for full compliance with the General Conditions, Plans and Specifications. This combined workmanship quality guarantee, and minimal equipment and materials warranty, shall apply to all matters reported by the OWNER in writing within said one (1) year period and this post-construction guarantee/warranty period shall be included in the coverage period set forth in the Performance Bond.

31. STATE SALES AND USE TAX EXEMPTION:

Pursuant to 34 Texas Administrative Code 3.291, in order for the Brownsville PUB to continue to benefit from its status as a State Sales and Use Tax Exempt Organization, after August 14, 1991, construction contracts must be awarded on a "separated contract" basis. A "separated contract" is one that distinguishes the value of the tangible personal property (materials such as pipe, bricks, lumber, concrete, paint, etc.) to be physically incorporated into the Project realty, from the total

Contract price. Under the "separated contract" format, the Contractor in effect becomes a "seller" to the Brownsville PUB of materials that are to be physically incorporated into the Project realty. As a "seller", the Contractor will issue a "Texas Certificate of Resale" to the supplier in lieu of paying the sales tax on materials at the time of purchase. The contractor will also issue a "Certificate of Exemption" to the supplier demonstrating that the personal property is being purchased for resale and that the resale is to the Brownsville PUB, which is a sales tax exempt entity under UTCA Tax Code Section 151.309(5). Contractors should be careful to consult the most recent guidelines of the State Comptroller of Public Accounts regarding the sales tax status of supplies and equipment that are used and/or consumed during project work (gas, oil, rental equipment), but that are not physically incorporated into the project realty. Such items are generally not tax exempt. Contractors that have questions about the implementation of this statute are asked to inquire directly with the State Comptroller of Public Accounts, Tax Administration Division, State of Texas, Austin, Texas 78774. Bidders will not include any federal taxes in bid prices since the City of Brownsville and Brownsville PUB are exempt from payment of such federal taxes. "Texas Certificates of Exemption", "Texas Certificates of Resale" and "Texas Sales Tax Permits" are forms available to the Contractor through the regional offices of the State Comptroller of Public Accounts.

BID
B005-20
Place: BPUB Purchasing Department
1495 Robinhood Dr.
Due Date: December 11, 2019 at 5:00 PM

Bid of _____ hereinafter called "BIDDER," a _____ (insert type of legal entity e.g. corporation, partnership, individual with d/b/a, etc.) organized and existing under the laws of the State of _____.

To: the Public Utilities Board of the City of Brownsville, Texas, hereinafter called "OWNER."

Gentlemen:

The BIDDER, acting as an independent contractor and in compliance with BPUB's invitation for bids for the **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3**, having examined the Specifications with related Documents and being familiar with all of the conditions, including the availability of materials and labor, hereby proposes to furnish all labor, materials and supplies, within the time set forth herein, and at the Prices shown in the attached Bid Schedule. These price(s) are to cover all expenses incurred in performing the Work required under the Contract Documents, of which this Bid is a part. These price(s) are firm and shall not be subject to adjustment provided this Bid is accepted within ninety (90) days after the time set for opening of bids.

BIDDER hereby agrees to commence Work under this Contract on or before a date to be specified in a written "Notice to Proceed" to be issued by the OWNER.

BIDDER agrees to perform all Work for which he contracts as described in the Plans and Specifications for the unit prices and/or lump sums shown on the attached Bid Schedule.

**BID SCHEDULE
BASE BID - B005-20
BROWNSVILLE PUBLIC UTILITIES BOARD**

The Bidder, in compliance with the Invitation for Bids for the SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3 having examined the scope of work and written Specifications, hereby proposes to furnish construction services for the following Unit prices and lump sums.

Items	DESCRIPTION (Write Unit Price in Words)	Est. Qty.	Unit	Unit Price*	Costs
1	Furnish and install 150 HP 1200 RPM Vertical Turbine Pump, including bowl assembly, column assembly and head assembly, spare parts, and computational fluid dynamic modeling of wetwell including freight Complete-In-Place for _____ Dollars and _____ Cents	1	EA	\$	\$
2	Furnish and Install 150 HP, 5008P US Titan VHS Motor WP11 ENCL. Random wound 1.0 Service factor on VFD including freight Complete-In-Place for _____ Dollars and _____ Cents	1	EA	\$	\$
3	Furnish and Install all piping, valves and fittings to include: pipe spools, butterfly valve, plug valve, slanted disk check valve, expansion fitting, bends, flange, couplings, air release valve assembly, nuts/bolts, gasket and pipe supports, etc., Complete-In-Place for _____ Dollars and _____ Cents	1	LS	\$	\$
4	Furnish and Install coating systems for transfer pump 1 and 2, piping, valves, and fittings Complete-In-Place for _____ Dollars and _____ Cents	1	LS	\$	\$

Items	DESCRIPTION (Write Unit Price in Words)	Est. Qty.	Unit	Unit Price*	Costs
5	Furnish and Install all electrical labor and equipment as detailed in the plans and specifications to include: Conduit system for Transfer Pumps 3&4, VFD Cable and Control Cable as indicated on the plans and specifications from source to load for Transfer Pump #3, provide and install a 225A breaker for existing Panel board, SCADA Integration for new pump and motor and any additional electrical labor and misc. materials needed for a fully functional system Complete-In-Place for _____ Dollars and _____ Cents	1	LS	\$	\$
6	Furnish and Install an 18 Pulse 150HP VFD including all Labor and Ancillary materials including integration and all necessary Harmonic Mitigation and dV/dT output filter for properly functioning transfer pump system Complete-In-Place for _____ Dollars and _____ Cents	1	LS	\$	\$
GENERAL CONSTRUCTION					
7	Furnish Mobilization (Not to Exceed 5% of Base Bid) Complete-in-Place for _____ Dollars and _____ Cents	1	LS	\$	\$

TOTAL AMOUNT OF BID (#1-7): \$ _____

TOTAL AMOUNT OF BID (#1-7): _____
_____ (written in words)

CONTRACTOR REPRESENTATIVE

NAME (PRINT): _____ **SIGN:** _____

DATE: _____

NOTE: Quantities are estimated. The Brownsville PUB reserves the right to increase or decrease quantities as allowed by Texas law (plus or minus 25%) and as deemed necessary by OWNER, without impacting the quoted unit prices. Prospective bidders are encouraged to visit and assess the existing Project site and structures prior to submitting a bid.

BIDDER Acknowledges receipt of the following Addenda:

SUBCONTRACTORS. The undersigned BIDDER proposes that he will be responsible to perform major portions of the Work at the Project site with his own forces and that specific portions of the Work not performed by the undersigned will be subcontracted and performed by the following subcontractors.

Work Subcontracted	Name of Subcontractor
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Bid amounts are to be legibly shown in both words and figures. In case of discrepancy, the unit price shown in words will govern.

The above unit prices shall include all labor, materials, excavation, bailing, shoring, removal, backfill, overhead, profit, insurance, etc., to cover the finished Work of the several kinds called for.

BIDDER understands that the OWNER reserves the right to reject any or all bids and to waive any informalities in the bidding.

BIDDER agrees that this bid shall be good and may not be withdrawn for a period of ninety (90) calendar days after the scheduled bid opening.

The undersigned hereby declares that only the persons or firms interested in the bid as principal or principals are named herein, and that no other persons or firms than are herein mentioned have any interest in this Bid or in the Contract to be entered into; that this Bid is made without connection with any other person, company, or parties likewise submitting a bid or bid; and that it is in all respects for and in good faith, without collusion or fraud.

Upon receipt of written notice of the acceptance of this bid, BIDDER will execute the formal Contract attached within ten (10) days and deliver the Bonds and Insurance Certificates as required under the GENERAL CONDITIONS. The Bid security attached in the sum of _____ (\$_____) is to become the property of the OWNER in the event the Contract, Bonds, and insurance certificates are not executed or delivered within the time above set forth, as mutually agreed to liquidated damages and not as a penalty for the delay and additional administrative expense to the OWNER caused thereby; otherwise the Bid security will be returned upon the signing of the Contract and delivering the approved Bonds and insurance certificates.

Seal affixed here if BID is by a Corporation:
Respectfully submitted,

By: _____
Signature (Failure to sign will disqualify bid)

Title

Address

Attest: _____

BID BOND

STATE OF TEXAS §

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF CAMERON §

THAT WE, the undersigned, _____ as Principal, and _____ as Surety, are hereby held and firmly bound unto the PUBLIC UTILITIES BOARD OF THE CITY OF BROWNSVILLE, TEXAS as OWNER in liquidated damages (not as a penalty) of _____ for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors and assigns.

Signed, this _____ day of _____, 2019.

The Condition of the above obligation is such that whereas the Principal has submitted to the OWNER a certain BID attached hereto and hereby made a part hereof to enter into a contract in writing, for **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3.**

NOW, THEREFORE,

- (a) If said BID shall be rejected, or
- (b) If said BID shall be accepted and the Principal shall execute and deliver a contract in the form of Agreement attached hereto (properly completed in accordance with said BID) and shall furnish payment and performance bonds for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall furnish insurance certificates, and shall in all other respects perform the agreement created by the acceptance of said BID, then this obligation shall be void. Otherwise the same shall remain in force and effect, it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by an extension of the time within which the OWNER may accept such BID; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

Signed, this _____ day of _____, 2019.

Principal

Surety

By: _____

IMPORTANT - Surety companies executing BONDS must be legally authorized by the State Board of Insurance to transact business in the State of Texas.

CONTRACTOR'S

PRE-BID DISCLOSURE STATEMENT

All questions must be answered or your bid will be deemed non-responsive and subject to rejection. The data given must be clear and comprehensive. **This statement must be notarized.** If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information he desires, so long as that information does not constitute a condition, qualification or exception to the Bid Submittal.

1. This Pre-Bid Disclosure Statement is submitted to the Brownsville Public Utilities Board by: _____
 ___ a Corporation, ___ a Partnership, ___ a Texas Joint Venture, or ___ an Individual.
 Address: _____ Contractor's #: _____
 City _____ State _____ Zip Code _____

2. Years in business under present business name: _____

3. Years of experience in construction work of the type called for in this contract as: A General Contractor _____, A Subcontractor _____.

4. What projects has your organization completed within the last five (5) years? List most recent FIRST.

Contract	Type of Work	Date Completed	Owners Name and Address	Amount

5. What projects does your organization have under way as of this date?

Contract	Type of Work	Date Completed	Owners Name and Address	Amount

6. Have you ever failed to complete any work awarded to you?
 ___ Yes ___ No. If "Yes", state where and why. _____

7. Are you at present in any binding arbitrations and/or lawsuits involving construction work of any type?
 ___ Yes ___ No. If "Yes", explain: _____

8. Explain in detail the manner in which you have inspected the work and jobsite proposed in this contract: _____

9. Explain in detail your plan or layout for performing the work proposed in this contract: _____

10. If this contract is awarded to you, your company's office administrative manager for the work will be Mr. (Ms.) _____, and your resident construction superintendent will be Mr. (Ms.) _____.

11. What experience in this type of work does the individual designated as resident superintendent above have? _____

12. What portions of the work do you intend to subcontract? _____

13. What equipment do you own that is available for the proposed work?

Quantity	Description, Size Capacity, Etc.	Condition	Years in Service	Present Location

14. Have you received firm offers from suppliers or manufacturers for all major items of material and/or equipment within the price totals used in preparing your bid? __ Yes __ No

15. Attach resumes for the principal members of your organization, including the officers as well as the proposed superintendent for the project.

Credit available: \$ _____ Bank Reference: _____

Bonding Capacity available: \$ _____

The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the Owner in verification of the recitals comprising this Pre-Bid Disclosure Statement.

The signatory of this questionnaire guarantees the truth and accuracy of all statements herein made and all answers herein expressed.

Dated this ____ day of _____, 2019.

By: _____

Title: _____

STATE OF _____

COUNTY OF _____

Subscribed and sworn to before me this ____ day of _____, 2019.

Notary Public
My commission expires: _____

**SUBCONTRACTOR'S
PRE-BID DISCLOSURE STATEMENT**

All questions must be answered or the general contractor's bid will be deemed non-responsive and subject to rejection. The data given must be clear and comprehensive. **This statement must be notarized.** If necessary, questions may be answered on separate attached sheets. The subcontractor may submit any additional information he desires.

1. This Pre-Bid Disclosure Statement is submitted to the Brownsville Public Utilities Board by:

_____ a Corporation, ___ a Partnership, ___ a Texas Joint Venture, or ___ an Individual.
 Address: _____ Contractor's #: _____
 City _____ State _____ Zip Code _____

2. Years in business under present business name: _____

3. Years of experience in construction work of the type called for in this contract as: A General Contractor _____, A Subcontractor _____.

4. Have you ever previously worked as a subcontractor for this general contractor?
 ___Yes___No; If yes, list the three most recent projects in which your company has served as a subcontractor to this general contractor.

5. What projects has your organization completed within the last five (5) years? List most recent FIRST.

Contract	Type of Work	Date Completed	Owners Name and Address	Amount

6. What projects does your organization have under way as of this date?

Contract	Type of Work	Date Completed	Owners Name and Address	Amount

7. Have you ever failed to complete any work awarded to you?

___ Yes ___ No. If "Yes", state where and why. _____

8. Are you at present in any finding arbitrations and/or lawsuits involving construction work of any type?

___ Yes ___ No. If "Yes", explain: _____

9. Explain in detail the manner in which you have inspected the work and jobsite proposed in this contract: _____

10. Explain in detail your plan or layout for performing the work proposed in this contract: _____

11. If this subcontract is awarded to you by the general contractor, your company's office administrative manager for the work will be Mr. (Ms.) _____,

and your resident construction superintendent will be Mr. (Ms.) _____.

12. What experience in this type of work does the individual designated as resident superintendent above have? _____

13. What portions of the work do you intend to subtier subcontract? _____

14. What equipment do you own that is available for the proposed work?

Quantity	Description, Size Capacity, Etc.	Condition	Years in Service	Present Location

15. Have you received firm offers from suppliers or manufacturers for all major items of material and/or equipment within the prices totals used in preparing your subcontractor bid?

Yes No

16. Attach resumes for the principal members of your organization, including the officers as well as the proposed superintendent for the project.

Credit available: \$ _____ Bank Reference: _____

Bonding Capacity available: \$ _____

The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the Engineer and Owner in verification of the recitals comprising this Pre-Bid Disclosure Statement.

The signatory of this questionnaire guarantees the truth and accuracy of all statements herein made and all answers herein expressed.

Dated this ____ day of _____, 2019.

By: _____

Title: _____

STATE OF _____

COUNTY OF _____

Subscribed and sworn to before me this ____ day of _____, 2019.

Notary Public

My commission expires: _____

NOTICE OF AWARD

TO:

Project Description: **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3**

Dear Sir/Madam:

The Owner has considered the BID submitted by you for the above-described Work, in response to its Legal Notice and Invitation for Bids and Instruction to Bidders, dated December 11, 2019.

You are hereby notified that your BID has been accepted in the amount of \$ _____.

You are required by the Instructions to Bidders to execute the attached Agreement and furnish any required Contractor's Performance Bond, Payment Bond and Certificates of Insurance within ten (10) calendar days from the date of this Notice to you.

Before Work commences, the material/equipment submittals will have to be approved by the BPUB representative Engineer. Signing of the Notice to Proceed and Purchase Order by BPUB are pending approval of the submittals.

If you fail to execute the attached Agreement and furnish any required Bonds and insurance certificates within ten (10) days from the date of this Notice, Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your bid as abandoned and as a forfeiture of your BID SECURITY.

The Owner will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this NOTICE OF AWARD to the Owner's Purchasing Department Manager.

Dated this _____ day of _____, 2019.

PUBLIC UTILITIES BOARD OF THE CITY OF BROWNSVILLE, TEXAS

By: _____
Name: John S. Bruciak
Title: General Manager / CEO

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged by:

_____ this ____ day
of _____, 2019.

By: _____

Name: _____

Title: _____

NOTICE TO PROCEED

TO:

ADDRESS:

Contract For: **SOUTHMOST REGIONAL WATER AUTHORITY
TRANSFER PUMP NO. 3**

You are notified that the Contract Time under the above Contract will commence to run on _____, 2020. By that date, you are to start performing your obligations under the Contract Documents. In accordance with the Agreement, the date of Substantial Completion prior to final payment is _____, 2020.

Before you may start any Work at the site, material submittals must be submitted and approved by the BPUB before a Purchase Order is issued and prior to the purchase and shipment of materials.

Brownsville Public Utilities Board:
(Owner)

BY: _____
(Authorized Signature)

NAME: John S. Bruciak

TITLE: General Manager/CEO

DATE: _____

AGREEMENT

THIS AGREEMENT is dated as of the _____ day of _____, 2019, by and between the PUBLIC UTILITIES BOARD of the City of Brownsville, Texas (hereinafter called OWNER) and _____ of _____ an independent contractor, hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

Article 1. WORK.

CONTRACTOR shall furnish all of the material, supplies, tools, equipment, labor and other services necessary for the construction and Final Completion of the Work described herein and complete all the Work as specified or indicated in the Contract Documents for **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3**.

Article 2. CONTRACT TIME

- 2.1 The Work shall be Substantially Completed and made ready for later final payment ONE HUNDRED EIGHTY (180) consecutive calendar days after the date when the Contract time commences to run as provided in paragraph 2.3 of the General Conditions and in the Notice to Proceed, and in accordance with paragraph 14.13 of the General Conditions.
- 2.2 **Liquidated Damages.** OWNER AND CONTRACTOR recognize that the **TIME OF PERFORMANCE IS OF THE ESSENCE** in this Agreement and that OWNER will suffer financial loss if the Work is not Substantially Complete within the time specified in paragraph 2.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. Both parties hereto also recognize the delays, expense and difficulties involved in proving in a legal proceeding the actual loss suffered by OWNER if the Work is not Substantially Complete on time. Accordingly, instead of requiring such proof, OWNER and CONTRACTOR agree that as liquidated damages, and not as a penalty, for the delay, CONTRACTOR shall pay OWNER three hundred dollars (\$300.00) for each consecutive calendar day that expires after the time specified in paragraph 2.1 for Substantial Completion.

Article 3. CONTRACT PRICE.

3.1 CONTRACTOR shall perform the Work described in the Contract Documents for the amounts shown in the Bid Schedule, and OWNER shall pay CONTRACTOR in current funds based on the Bid Schedule.

Article 4. PAYMENT PROCEDURES.

Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by OWNER as provided for in the General Conditions.

4.1 Progress Payments. OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment on or about the Twentieth (20th) day after submittal of the Application for Payment each month as provided below. All progress payments shall be on the basis of the progress of the Work measured by the Schedule of Values provided for in paragraph 14.1 of the General Conditions.

4.1.1 Prior to Substantial Completion, progress payments shall be in an amount equal to 95% of the amount requested in the Application for Payment, with 5% remaining as retainage for the Project, to be released in accordance with paragraph 4.2.

4.1.2 Upon Substantial Completion, OWNER shall pay an amount sufficient to increase total payments to CONTRACTOR to 95% of the Contract price, less such amounts OWNER shall determine in accordance with paragraph 14.7 of the General Conditions.

4.2 **Final Payment.** Upon Final Completion and acceptance of the Work in accordance with paragraph 14.13 of the General Conditions, OWNER shall pay the remainder of the Contract price as provided in said paragraph 14.13.

Article 5. CONTRACTOR'S REPRESENTATIONS.

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations:

5.1 CONTRACTOR has familiarized himself with the nature and extent of the Contract Documents, Work, locality, and with all local conditions and federal, State and local laws, ordinances, rules and regulations that in any manner may affect cost, progress or performance of the Work.

5.2 CONTRACTOR has made or caused to be made examinations and investigations of information and the Project site as he deems necessary for the performance of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations or similar data are or will be required by CONTRACTOR for such purposes.

5.3 CONTRACTOR has given OWNER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents and the written resolution thereof by OWNER is acceptable to CONTRACTOR.

5.4 CONTRACTOR is skilled and experienced in the type of work described in the Contract Documents.

Article 6. CONTRACT DOCUMENTS.

The Contract Documents which comprise the entire Agreement between OWNER and CONTRACTOR are attached to this Agreement, made a part hereof and consist of the following:

- 6.1 Legal Notice and Invitation to Bid
- 6.2 Instructions to Bidders
- 6.3 Bid and Bid Schedule
- 6.4 Bid Bond.
- 6.5 Contractor's and Subcontractor's Pre-Bid Disclosure Statements
- 6.6 Notice of Award and Acceptance of Notice
- 6.7 Notice to Proceed
- 6.8 Agreement
- 6.9 Performance Bond.
- 6.10 Payment Bond.
- 6.11 General Conditions
- 6.12 Supplementary General Conditions
- 6.13 Technical Specifications
- 6.14 Addendum number(s)
- 6.15 CONTRACTOR's Certificate(s) of Insurance.
- 6.16 Any written modification, including Change Orders, duly delivered after execution of this Agreement.

There are no Contract Documents other than those listed above in this Article 6. The Contract Documents may only be altered, amended or repealed by a written Modification (as defined in Article 1 of the General Conditions).

Article 7. MISCELLANEOUS.

7.1 Terms used in this Agreement, which are defined in Article 1 of the General Conditions shall have the meanings indicated in the General Conditions.

7.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically, but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

7.3 OWNER and CONTRACTOR each binds himself, his partners, successors, assigns and legal representatives to the other party hereto, his partners, successors, assigns and

legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

7.4 The invalidity or unenforceability of any provision of the Contract Documents shall not affect the validity or enforceability of any other provision of the Contract Documents.

7.5 This Agreement and the Contract Documents are subject to all applicable laws, statutes, codes, ordinances, rules and regulations.

7.6 In the event of default by CONTRACTOR under the Contract Documents, OWNER shall have all rights and remedies afforded to it at law or in equity to enforce the terms of the Contract Documents. The exercise of any one right or remedy shall be without prejudice to the enforcement of any other right or remedy allowed at law or in equity.

7.7 If any action at law or in equity is necessary by OWNER to enforce or interpret the terms of the Contract Documents, OWNER shall be entitled to reasonable attorneys' fees and costs and any necessary disbursements, in addition to any other relief to which the OWNER is entitled.

7.8 The Contract Documents constitute the entire agreement between the parties hereto and supersede all prior agreements, understandings, or oral communications between the parties. The Contract can only be modified or amended by written agreement of the parties.

7.9 These Contract Documents are governed by the laws of the State of Texas and the parties agree that venue for any lawsuits arising from these Contract Documents shall be set in Cameron County, Texas.

IN WITNESS WHEREOF, the parties hereto have signed this Agreement in triplicate originals. One counterpart each has been delivered to OWNER and CONTRACTOR. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR. This Agreement will be effective on the date signed by the OWNER below.

PUBLIC UTILITIES BOARD
OF THE CITY OF BROWNSVILLE

(Insert Contractor's Name)

By: _____ By: _____

Name _____ Name _____

Title _____ Title _____

Date _____ Date _____

Attest: _____ Attest: _____

Address for giving notices:

Address for giving notices:

Attn: Alfredo J. Resendez, P.E.
1425 Robinhood Drive
Brownsville, TX 78521
(956) 983-6572

Attn: _____

Contractor hereby acknowledges and understands that this is a "separated contract" pursuant to 34 T.A.C. 3.291. The following amount of money represents that part of the total Contract price representative of the value of tangible personal property to be physically incorporated into the Project realty: \$_____.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

THAT _____
(Name of Contractor)

(Address of Contractor)

a _____
(corporation, partnership, or individual)

hereinafter called Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto the PUBLIC UTILITIES BOARD of the City of Brownsville, Texas, hereinafter called OWNER, in liquidated damages (not as a penalty) of _____ Dollars (\$_____) in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain Contract with the OWNER, dated the ____ day of _____, 2019, a copy of which is hereto attached and made a part hereof, for the construction of the: **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3.**

NOW, THEREFORE, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions, and agreements of said Contract during the original term thereof, and any extensions thereof which may be granted by the OWNER, with or without notice to the Surety and during the one (1) year post-construction workmanship guaranty and materials/equipment warranty period, and if he shall satisfy all claims and demands incurred under such Contract, and **SHALL FULLY INDEMNIFY AND SAVE HARMLESS THE OWNER FROM ALL COSTS AND DAMAGES WHICH IT MAY SUFFER BY REASON OF FAILURE TO DO SO**, and shall reimburse and repay the OWNER all outlay and expense which the OWNER may incur in making good any default, then this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, FURTHER, that the said surety, for value received, hereby stipulates and agrees that no written change, extension of time, alteration or addition to the terms of the Contract or to WORK to be performed thereunder, or the SPECIFICATIONS accompanying the same, shall in any ways affect its obligation on this BOND, and it does hereby waive notice of any such written change, extension of time, alteration or addition to the terms of the Contract, or to the WORK, or to the SPECIFICATIONS.

PROVIDED, FURTHER, that no final settlement between the OWNER and the CONTRACTOR

shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

This bond is subject to and governed by Section 2253.02 of the Texas Government Code (Vernon's Texas Codes Annotated) and Article 7.19-1 of Vernon's Texas Insurance Code and all amendments thereto.

IN WITNESS WHEREOF, this instrument is executed in triplicate, each counterpart of which shall be deemed an original, this the ____ day of _____, 2019.

ATTEST: _____
(Principal)

(Principal) Secretary By: _____ (s)
(Signature)

(SEAL)

(Witness as to Principal) _____
(Address) _____

(Address)

ATTEST: _____
(Surety)

(Surety) Secretary By: _____
(Attorney-in-Fact)

(SEAL)

(Witness as to Surety) _____
(Address) _____

(Address)

NOTE: Date of BOND must not be prior to date of Contract. If Contractor is a Partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must be legally authorized by the State Board of Insurance to transact business in the State of Texas.

ATTACH POWER OF ATTORNEY

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS:

THAT _____
(Name of Contractor)

(Address of Contractor)

a _____
(corporation, partnership, or individual)

hereinafter called Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto the PUBLIC UTILITIES BOARD of the City of Brownsville, Texas, hereinafter called OWNER, in liquidated damages (not as a penalty) of _____ Dollars (\$_____) in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain Contract with the OWNER, dated the ____ day of _____, 2019, a copy of which is hereto attached and made a part hereof, for the construction of the: **SOUTHMOST REGIONAL WATER AUTHORITY TRANSFER PUMP NO. 3.**

NOW, THEREFORE, if the Principal shall promptly make payment to all persons, firms, SUBCONTRACTORS, and corporations furnishing materials, for or performing labor in, the prosecution of the WORK provided for in such Contract, and any authorized extension or modification thereof, including all amounts due for materials, lubricants, oil, gasoline, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such WORK, and all insurance premiums on said WORK, and for all labor, performed in such WORK whether by SUBCONTRACTOR or otherwise, then this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, FURTHER, that the said surety, for value received hereby stipulates and agrees that no written change, extension of time, alteration or addition to the terms of the Contract or to WORK to be performed there under, or the SPECIFICATIONS accompanying the same, shall in any ways affect its obligation on this BOND, and it does hereby waive notice of any such written change, extension of time, alteration or addition to the terms of the Contract, or to the WORK, or to the SPECIFICATIONS.

PROVIDED, FURTHER, that no final settlement between the OWNER and the CONTRACTOR shall abridge any remaining legal right of any beneficiary hereunder, whose timely filed and legally perfected claim may be unsatisfied.

This bond is subject to and governed by Section 2253.02 of the Texas Government Code (Vernon's Texas Codes Annotated) and Article 7.19-1 of Vernon's Texas Insurance Code and all amendments thereto.

IN WITNESS WHEREOF, this instrument is executed in triplicate, each counterpart of which shall be deemed an original, this the ____ day of _____, 2019.

ATTEST: _____
(Principal)

(Principal) Secretary By: _____ (s)
(Signature)

(SEAL)

(Witness as to Principal) _____
(Address)

(Address)

ATTEST: _____
(Surety)

(Surety) Secretary By: _____
(Attorney-in-Fact)

(SEAL)

(Witness as to Surety) _____
(Address)

(Address)

NOTE: Date of BOND must not be prior to date of Contract. If Contractor Partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must be legally authorized by the State Board of Insurance to transact business in the State of Texas.

ATTACH POWER OF ATTORNEY

**GENERAL CONDITIONS
OF THE
CONSTRUCTION CONTRACT**

Prepared by
The Public Utilities Board of the City of Brownsville, Texas
as an Adaptation From the 1983 Base Document Prepared by

Engineers' Joint Contract Documents Committee

and originally

Issued and Published Jointly By:

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A practice division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

AMERICAN CONSULTING ENGINEERS COUNCIL

AMERICAN SOCIETY OF CIVIL ENGINEERS

CONSTRUCTION SPECIFICATION INSTITUTE

The base document from which this adaptation was prepared
(1983 edition) was approved and endorsed by:

The Associated General Contractors of America

TABLE OF CONTENTS OF STANDARD GENERAL CONDITIONS

Article Number	Title
1	DEFINITIONS
2	PRELIMINARY MATTERS
3	CONTRACT DOCUMENTS: INTENT, AMENDING AND REUSE
4	AVAILABILITY OF LANDS: PHYSICAL CONDITIONS: REFERENCE POINTS
5	BONDS AND INSURANCE
6	CONTRACTOR'S RESPONSIBILITIES
7	OTHER WORK
8	OWNER'S RESPONSIBILITIES
9	ENGINEER'S STATUS DURING CONSTRUCTION
10	CHANGES IN THE WORK
11	CHANGE OF CONTRACT PRICE
12	CHANGE OF CONTRACT TIME
13	WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK
14	PAYMENTS TO CONTRACTOR AND COMPLETION
15	SUSPENSION OF WORK AND TERMINATION
16	TIME FOR SUBSTANTIAL COMPLETION AND LIQUIDATED DAMAGES
17	MISCELLANEOUS

GENERAL CONDITIONS

SCOPE. The Standard General Conditions of the Construction Contract prepared by the National Society of Professional Engineers (NSPE-1910-8, 1983 Edition) as amended and adapted by the OWNER to meet local requirements, shall form a part of this Contract, together with the following Supplementary General Conditions. A copy of the locally amended Standard General Conditions (based upon NSPE-1910-8) is bound herewith. The following supplements modify, change, delete, or add to the General Conditions. Where any part of the General Conditions is modified or voided by these Articles, the unaltered provisions of that part shall remain in effect.

ARTICLE 1. DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

Addenda - Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the bidding documents or the Contract Documents. These Addenda are a part of the Contract Documents and modify the Drawings, Specifications or other bid documents as indicated. No verbal changes in the Work not depicted or described in writing shall be binding.

Supplements to, changes in, or corrections to the Drawings and/or Specifications issued in writing by OWNER during the period of bidding. These Addenda are a part of the Contract and modify the drawings and/or specifications as indicated. No verbal changes in the work as shown or described shall become binding.

Agreement - The written and signed short-form Agreement (Contract) between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents including these General Conditions are attached to the Agreement and made a part thereof as provided therein.

Alternates. Additions; deletions from; or changes to requirements for the Project, each of which shall be bid separately and shall be included in or deleted/deducted from the Contract at the discretion of OWNER.

Application for Payment - The form developed by OWNER which is to be used by CONTRACTOR in requesting interim progress or final Contract payments and which is to include such supporting documentation as is required by the Contract Documents.

Bid - The written offer or bid of the bidder submitted on the OWNER prescribed form setting forth in figures and in script, the prices for the Work to be performed.

Bonds - Bid, Performance and Payment Bonds and any other instruments of security.

Calendar Day - A calendar day of twenty-four hours is measured from midnight, to the next midnight, and shall constitute a single calendar day. Calendar days include Saturdays and Sundays. This is a Calendar Day Contract.

Change Order - A document developed by OWNER, which is signed by CONTRACTOR and OWNER and authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Agreement. Approved Change Orders are part of the Contract Documents.

Contract Documents - The Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are more specifically identified in the Agreement, together with all amendments, modifications, later approved Change Orders and supplements issued pursuant to paragraphs 3.4 and 3.5 on or after the Effective Date of the Agreement.

Contract Price - The moneys payable by OWNER to CONTRACTOR under the Contract Documents as stated in the Agreement (subject to the provisions of paragraph 11.9.1 in the case of Unit Price Work).

Contract Time - The number of days ("calendar" or "working" days computed as provided in paragraph 17.2) or the date specifically stated in the Agreement for the Substantial Completion of the Work.

CONTRACTOR - The person, firm or corporation with whom OWNER has entered into the Agreement to construct the Work.

Defective - An adjective which when modifying the word "Work" refers to "Work" that is unsatisfactory, faulty or deficient, or does not conform to, or comply with the Contract Documents, or does not meet the requirements of any inspection, referenced standard, test or approval referred to in the Contract Documents, or has been damaged prior to the time OWNER makes the final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with paragraph 14.8 or 14.10).

Drawings - The drawings (plans) which depict the character, design, and scope of the Work to be performed and which have been prepared and/or approved by OWNER and are referred to in the Contract Documents.

Effective Date of the Agreement - The date indicated in the Agreement document upon which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed by OWNER.

Engineer- The OWNER - designated Brownsville P.U.B. in-house staff registered professional person, named as the OWNER's engineering representative for the Project. There is no outside independent engineering consultant anticipated to be retained by OWNER for this Project.

Field Order - A written order issued by OWNER which orders minor changes or interpretations in the Work in accordance with paragraph 9.5, but which does not involve a change

in the Contract Price or the Contract Time.

Furnish. To supply at the jobsite the material, equipment, etc., referred to. Installation is not required of the supplier by the specifications, but shall be arranged for by the General CONTRACTOR.

General Requirements – Division 1 of the Specifications.

Laws and Regulations; Laws or Regulations - Federal and/or State Laws, rules, administrative agency regulations, local ordinances, local codes and/or court orders.

Notice of Award - The written notice by OWNER to the apparent successful bidder stating that upon compliance by the apparent successful bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.

Notice to Proceed - A written notice given by OWNER to CONTRACTOR fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.

OWNER - The City of Brownsville, acting through its Public Utilities Board of the City of Brownsville, Texas and its authorized representatives.

Partial Utilization - Placing a portion of the Work in service for the benefit of the OWNER and for the purpose for which it is intended (or a related purpose) before reaching Substantial Completion for all the Work.

Project - The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

Provide. To furnish and install the material, equipment, etc. referred to, at the location shown or otherwise approved at the Project job-site.

Resident Project Representative - The authorized representative of OWNER who is assigned to periodically observe the site of the Project, or any part thereof, on behalf of OWNER.

Shop Drawings - All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by, or for CONTRACTOR, to illustrate some portion of the Work, and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a Supplier and submitted by CONTRACTOR, to illustrate material or equipment for some portion of the Work.

Specifications - Those portions of the Contract Documents consisting of written technical descriptions for the design configuration and/or performance standard of materials, equipment, any specified construction systems, standards and workmanship, as applied to the Work and certain administrative details applicable thereto.

Standard Abbreviations. Wherever reference is made to standard specifications,

standards of quality or performance, as established by a recognized national authority, the reference may be by initials and acronyms as generally recognized throughout the industry.

Subcontractor - An individual, firm or corporation having a direct contract with CONTRACTOR, or with any other Subcontractor (subtier), for the performance of a part of the Work at the Project site.

Substantial Completion - (See generally paragraph 14.8) The Work (or a specified part thereof) has progressed to the point where, in the opinion of OWNER as evidenced by its definitive written and signed certificate of Substantial Completion, it is apparently sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the OWNER's purposes for which it is intended; or if there is no such certificate issued, when final payment is due in accordance with paragraph 14.13. The terms "Substantially Complete" and "Substantially Completed" as applied to any Work refer to the Substantial Completion thereof.

Supplementary Conditions - The part of the Contract Documents which amends or supplements these General Conditions.

Supplier - A manufacturer, fabricator, supplier, distributor, materialman or third-party vendor.

Underground Facilities - All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any outer encasements containing such facilities (vaults) which have been installed underground to furnish/transport any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other related data communications, cable television, sewage, storm drainage, traffic or other electronic control systems or potable water.

Unit Price Work - Work to be paid for on the basis of unit prices for OWNER estimated quantities.

Work - The entire completed construction or the various separately identifiable parts thereof, required to be furnished by the CONTRACTOR under the Contract Documents. Work is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

Work Directive Change - A written directive to CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by OWNER, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.2 or 4.3 or to emergencies under paragraph 6.22. A Work Directive Change may not change the Contract Price or the Contract Time, but is evidence that the parties expect that the change directed or documented by a Work Directive Change will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Time as provided in paragraph 10.2.

Working Day. A week day (Monday through Friday only, inclusive) in which weather conditions are such that Work can be performed in a normal manner. Weekends (Saturday,

Sunday) and holidays shall not be considered working days. This Contract is not a Working Day Contract.

Written Amendment - A written amendment of the Contract Documents, signed by OWNER and CONTRACTOR on or after the Effective Date of the Agreement and normally dealing with the non-engineering or non-technical (commercial terms, legal provisions, etc.), rather than strictly Work-related, aspects of the Contract Documents. Written Amendments are normally embodied in a Change Order once construction commences.

ARTICLE 2. PRELIMINARY MATTERS

Delivery of Bonds:

2.1 When CONTRACTOR delivers the executed Agreements to OWNER, CONTRACTOR shall also deliver to OWNER such Bonds as CONTRACTOR may be required to furnish in accordance with paragraph 5.1.

Copies of Documents:

2.2 OWNER shall furnish to CONTRACTOR up to five (5) copies (unless otherwise specified in the Supplementary Conditions) of the Contract Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished to CONTRACTOR, upon request, at the cost of reproduction reimbursable to OWNER.

Commencement of Contract Time; Notice to Proceed:

2.3 The Contract Time will commence to run on the date indicated in the Notice to Proceed. A Notice to Proceed may be given by Owner at any time after the Effective Date of the Agreement. The CONTRACTOR might not yet be actually performing Work after Contract Time commences.

Starting the Project:

2.4 CONTRACTOR is obligated to perform the Work on the date when the Contract Time commences to run, but no Work shall be done at the Project site prior to the date on which the Contract Time commences to run per the Notice to Proceed.

Before Starting Construction:

2.5 Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to OWNER any conflict, error or discrepancy which CONTRACTOR may discover and shall obtain a written interpretation or clarification from OWNER's Engineer before proceeding with any Work affected thereby, however CONTRACTOR shall not be liable to OWNER for failure to report any conflict, error or discrepancy in the Contract Documents, unless CONTRACTOR had actual knowledge thereof or should reasonably have known thereof pursuant to customary construction industry

standards.

2.6 Within ten (10) calendar days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), CONTRACTOR shall submit to OWNER for review:

2.6.1 an estimated Work Progress Schedule indicating the starting and completion dates of the various critical stages of the Work; and

a preliminary schedule of Shop Drawing submissions; and

2.6.2 a preliminary Schedule of Values for all of the Work, which will include quantities and prices of items aggregating the total Contract Price and will subdivide the Work into logical component parts in sufficient detail to serve as the basis for progress payments during construction. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work which will be automatically confirmed in writing by CONTRACTOR at the time of submission to OWNER.

2.7 By the tenth (10th) calendar day after award of the Contract by OWNER, CONTRACTOR shall deliver to OWNER original certificates (and any other evidence of insurance requested by OWNER) which CONTRACTOR is required to purchase and maintain in accordance with Article 5.

Preconstruction Conference:

2.8 After the Effective Date of the Agreement, but before CONTRACTOR starts the Work at the Project site, a mandatory conference attended by CONTRACTOR, OWNER and others as appropriate, will be held to discuss the Schedules referred to in paragraph 2.6, to discuss procedures for handling Shop Drawings and other submittals and for processing Applications for Payment; and to establish a working and pragmatic understanding among the parties as to the general progress and administration of the Work.

Finalizing Schedules:

2.9 At least ten (10) calendar days before submission of the first Application for Payment, a mandatory conference attended by CONTRACTOR, OWNER and others as appropriate, will be held to finalize the Schedules submitted in accordance with paragraph 2.6. The finalized Progress Schedule will be made acceptable to OWNER as providing an orderly progression of the Work to completion within the Contract Time, but such OWNER acceptance will neither impose on OWNER responsibility for the progress or scheduling of the Work, nor relieve CONTRACTOR from full responsibility therefore. The finalized Schedule of Shop Drawing submissions will be acceptable to OWNER's Engineer as providing a workable arrangement for processing the submissions for review. The finalized Schedule of Values will be made acceptable to OWNER's Engineer as to form and substance.

ARTICLE 3. CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

Intent:

3.1 The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the Work. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of Cameron County, Texas.

3.2 It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials or equipment that may reasonably be inferred from the Contract Documents as being required of CONTRACTOR to produce the OWNER'S intended result will be supplied by CONTRACTOR, whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe Work, materials or equipment, such words shall be interpreted in accordance with that meaning. Reference to standard specifications, manuals or codes of any technical society, organization or association, whether such reference be specific or by implication, shall mean the latest amended standard specification, manual, code or Laws or Regulations in effect at the time of opening of Bids (or, on the Effective Date of the Agreement, if there were no Bids), except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change the duties and responsibilities of OWNER, CONTRACTOR, or any of their consultants, agents or employees from those set forth in the Contract Documents. Clarifications and interpretations of the Contract Documents shall be issued by OWNER's Engineer in writing as provided in paragraph 9.4.

3.3 If, during the performance of the Work, CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, CONTRACTOR shall so report to OWNER's Engineer in writing immediately, and before proceeding with the Work affected thereby, and CONTRACTOR shall obtain a written interpretation or clarification from OWNER's Engineer, however, CONTRACTOR shall not be liable to OWNER for failure to report any conflict, error or discrepancy in the Contract Documents unless CONTRACTOR had actual knowledge thereof, or should reasonably have known thereof pursuant to customary construction industry standards.

Amending and Supplementing Contract Documents:

3.4 The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following written ways:

- 3.4.1 a formal Written Amendment,
- 3.4.2 a Change Order (pursuant to paragraph 10.4), or
- 3.4.3 a Work Directive Change (pursuant to paragraph 10.1).

As indicated in paragraphs 11.2 and 12.1, Contract Price and Contract Time may only be changed by a Change Order or a Written Amendment.

3.5 In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:

3.5.1 a Field Order (pursuant to paragraph 9.5),

3.5.2 OWNER Engineer's approval of a Shop Drawing or sample (pursuant to paragraphs 6.26 and 6.27), or

3.5.3 OWNER Engineer's written interpretation or clarification (pursuant to paragraph 9.4).

Reuse of Documents:

3.6 Neither CONTRACTOR nor any Subcontractor or Supplier, or other person or organization performing or furnishing any of the Work under a direct contract or Project involvement with OWNER, shall have or acquire any title to, or ownership rights in, any of the Drawings, Specifications or other Contract Documents (or copies of any thereof) prepared by or bearing the seal of OWNER's Engineer, and they shall not reuse any of them on extensions of the Project or any other project without written consent of OWNER and specific written verification or adaptation by OWNER's Engineer. All Drawings, Specifications or other Documents (or copies of any thereof) are upon completion of the Project to become the property of OWNER. Further use thereof without written consent of OWNER and OWNER'S Engineer is prohibited and solely at the risk of the user.

ARTICLE 4. AVAILABILITY OF LANDS: PHYSICAL CONDITIONS: REFERENCE POINTS

Availability of Lands:

4.1 OWNER shall furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way, licenses and easements for access thereto and such other lands which are specifically designated by OWNER for the use of CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. If CONTRACTOR believes that any delay in OWNER's furnishing of these lands, rights-of-way, licenses or easements entitles CONTRACTOR to an extension of the Contract Time, CONTRACTOR may make a claim therefore as provided in Article 12. CONTRACTOR shall provide at his sole cost and option for any and all additional lands and access thereto not specifically provided by OWNER that CONTRACTOR may perceive are required for staging, temporary construction facilities, or storage of materials and equipment.

4.2 Physical Condition:

4.2.1 Explorations and Reports: Reference is made to the Supplementary

Conditions for any identification of any reports of geotechnical explorations and tests of subsurface conditions at the Project site that may have been utilized by OWNER's Engineer in preparation of the Contract Documents. Any of these geotechnical Explorations and Reports are expressly not part of these Contract Documents. CONTRACTOR may not rely upon the accuracy of the technical data contained in any such reports, nor upon non-technical data, interpretations or opinions contained therein or for the completeness thereof for CONTRACTOR's purposes. Except as indicated in the immediately preceding sentence and in paragraph 4.2.6, CONTRACTOR shall have full responsibility with respect to exploring, testing and encountering any subsurface conditions at the Project site.

4.2.2 **Existing Structures:** Reference is made to the Supplementary Conditions for any identification of those Drawings of physical conditions in or relating to existing surface or subsurface structures (except Underground Facilities referred to in paragraph 4.3) which are at or contiguous to the Project site that have been utilized by OWNER's Engineer in preparation of the Contract Documents. CONTRACTOR may rely upon the accuracy of the technical data actually contained in such drawings, but not for the current conditions or completeness thereof for CONTRACTOR's purposes. Except as indicated in the immediately preceding sentence and in paragraph 4.2.6, CONTRACTOR shall have full responsibility with respect to current locating, verification, investigation of, and encountering physical conditions in or relating to such structures.

4.2.3. **Report of Differing Conditions:** If CONTRACTOR believes that:

4.2.3.1 any technical data on which CONTRACTOR is entitled to rely as provided in paragraphs 4.2.1 and 4.2.2 is inaccurate, or

4.2.3.2 any physical condition uncovered or revealed at the Project site differs materially from that indicated, reflected or referred to in the Contract Documents,

CONTRACTOR shall, promptly after becoming aware thereof and before performing any Work in connection therewith (except in an emergency as permitted by paragraph 6.22), notify OWNER's field representative and OWNER's Engineer in writing about the inaccuracy or difference.

4.2.4 **OWNER's Review:** OWNER's Engineer will promptly review the pertinent conditions, determine the necessity of either CONTRACTOR or OWNER obtaining additional physical or geotechnical explorations or tests with respect thereto, and advise CONTRACTOR in writing of the findings and conclusions.

4.2.5 **Possible Document Change:** If OWNER's Engineer concludes that there is a material error in the Contract Documents, or that because of newly discovered, latent physical conditions, a change in the Contract Documents is required, a Work Directive Change or a Change Order may be issued as provided in Article 10 to reflect and document the consequences of the inaccuracy or difference.

4.2.6 **Possible Price and Time Adjustments:** In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, or any combination thereof, may be allowable to the extent that they are attributable to any such inaccuracy or difference. If OWNER and CONTRACTOR are unable to agree as to the amount

or length thereof, a CONTRACTOR claim may be made therefore as provided in Articles 11 and 12. All increases or decreases in the Contract Price shall be governed by all State and local statutes, codes, laws, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Physical Conditions

4.3 Underground Facilities:

4.3.1 Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Project site is only based on existing available information and data furnished to OWNER by the owners of such Underground Facilities, (utilities, pipeline companies, railroads, etc.) or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.3.1.1 OWNER shall not be responsible for the actual current conditions, accuracy or completeness of any such third-party information or data; and,

4.3.1.2 CONTRACTOR shall have full responsibility for reviewing and checking all such current information and data; for locating all current Underground Facilities shown or indicated in the Contract Documents, for coordination of the Work with the owners of such Underground Facilities during construction; for the safety and protection thereof as provided in paragraph 6.20 and; paying for the repair of any damage thereto resulting from the Work; the cost of all of which will be mutually considered between OWNER and CONTRACTOR as having been included in the CONTRACTOR'S original Contract Price.

4.3.2 Not Shown or Indicated: If an Underground Facility is uncovered or revealed at or contiguous to the Project site which was not shown or indicated in the Contract Documents, and which CONTRACTOR could not reasonably have been expected to be aware of under customary construction industry standards, CONTRACTOR shall, promptly after becoming aware thereof and before performing any Work affected thereby (except in an emergency as permitted by paragraph 6.22), identify the owner of such Underground Facility and give written notice thereof to that owner and to OWNER's Engineer. OWNER's Engineer will promptly review the Underground Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground Facility, and the Contract Documents may be amended or supplemented to the extent necessary. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility as provided in paragraph 6.20. CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Time, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the Contract Documents, and which CONTRACTOR could not reasonably have been expected to be aware of pursuant to customary construction industry standards. If the parties are unable to agree as to the amount or length thereof, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12. All increases or decreases in the Contract Price shall be governed by all State and local statutes, codes, laws, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Reference Points:

4.4. OWNER shall provide CONTRACTOR with any reasonably current and existing engineering surveys to assist CONTRACTOR to establish reference points for construction, which in OWNER Engineer's judgment are adequate to enable a skilled CONTRACTOR to proceed with the Work pursuant to customary construction industry standards. CONTRACTOR shall be responsible for laying out the Work (unless otherwise specifically specified by OWNER in the General Requirements), and shall protect and preserve the established reference points and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to OWNER's Engineer whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations, and CONTRACTOR shall be responsible for the accurate replacement or relocation of such reference points by professionally qualified personnel.

ARTICLE 5. BONDS AND INSURANCE

Performance and Payment Bonds:

For a Contract in excess of \$100,000.00, a Performance Bond shall be executed in the full amount of the Contract conditioned upon the faithful performance of the Work in accordance with the Plans, Specifications and Contract Documents. Said Bond shall be solely for the protection of the OWNER.

For a Contract in excess of \$50,000.00, a Payment Bond shall be executed in the full amount of the Contract, solely for the primary protection of all proper claimants against the surety for payment in supplying labor and material in the prosecution of the Work provided for in the Contract, for the use of each such claimant timely perfecting a proper claim against surety.

5.1 CONTRACTOR shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance of the Work and payment of all CONTRACTOR's labor, materials and supply obligations under the Contract Documents. **These bonds shall remain in effect at least until one year after the date when final payment becomes due**, except as otherwise provided by Law or Regulation or by the Contract Documents. CONTRACTOR shall also furnish any such other Bonds as may be required by the Supplementary Conditions. All Bonds shall be in the forms prescribed by Law or Regulation or by the Contract Documents and be executed by such sureties as are authorized to do business in the State of Texas. All Bonds signed by an agent must be accompanied by a certified copy of the authority to act on behalf of the surety.

5.2 If the surety on any Bond furnished by CONTRACTOR is declared a bankrupt or becomes insolvent, or its right to do business is terminated in Texas or it ceases to meet the requirements of paragraph 5.1, CONTRACTOR shall within five (5) calendar days thereafter substitute another Bond or surety, both of which must be acceptable to OWNER.

Contractor's Liability Insurance:

5.3 CONTRACTOR shall purchase and maintain such commercial general liability and

other insurance coverages as are appropriate for the Work being performed and furnished, and as will provide protection from claims set forth below which may arise out of, or result from, CONTRACTOR's performance and furnishing of the Work and CONTRACTOR's other obligations under the Contract Documents; whether it is to be performed or furnished by CONTRACTOR, by any Subcontractor, by anyone directly or indirectly employed by any of them to perform or furnish any of the Work; or by anyone for whose acts and/or omissions any of them may be liable:

5.3.1 Claims under workers' compensation, disability benefits and other similar employee benefit acts. This is a Texas public works Contract and rejection of the worker's compensation act, and thereby substituting a CONTRACTOR'S self-insurance reserve, is specifically disallowed.

5.3.2 Claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees traditionally covered by employer's liability insurance;

5.3.3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees;

5.3.4 Claims for damages insured by personal injury liability coverage which are sustained (a) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR; or (b) by any other person for any other reason;

5.3.5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting there from;

5.3.6 Claims arising out of operation of Laws or Regulations for damages because of bodily injury or death of any person or for damage to property; and

5.3.7 Claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any owned or hired motor vehicle.

The various insurance coverages required by these paragraphs 5.3 and 5.6 shall include the specific type coverage and be written for not less than the limits of liability and coverage amounts provided herein below or in the Supplementary Conditions, or required by law, whichever is greater. The commercial general liability insurance shall include completed operations insurance. All of the policies of insurance so required to be purchased and maintained (or the certificates or other evidence thereof) shall be of an "occurrence"-type, when applicable, and shall contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least (30) thirty days prior written notice has been given to OWNER by certified mail. All such insurance shall remain in effect until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing defective Work in accordance with paragraph 13.12. In addition, CONTRACTOR shall maintain such completed operations insurance for at least two (2) years after final payment and furnish OWNER with evidence of continuation of such insurance at final payment and one year thereafter. All insurance coverage

furnished under the Contract Documents shall include the City of Brownsville and BPUB as OWNER, and their respective public officials, officers, board members, and employees, as named additional insureds and hereinafter known as "additional insureds."

Contractual Liability Insurance:

5.4 The Commercial general liability insurance required by paragraph 5.3 will include contractual liability insurance applicable to CONTRACTOR's INDEMNITY obligations under paragraphs 6.32 and 6.33.

5.5 Specific Coverages of Insurance Required by Owner:

5.5.1 Workmen's Compensation and Employer's Liability. This insurance shall protect the laborer, and insure the CONTRACTOR, and insulate the additional insureds, against all claims under applicable Texas workmen's compensation laws, pursuant to Section 5.3.1. The additional insureds shall also be protected under an Employer's Liability policy against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workmen's compensation law. This Employer's Liability policy shall include an "all states" endorsement.

5.5.2. Mandatory TWCC Rule 28 TAC Sect. 110.110 Language

(A) **Definitions:**

Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the Commission, or a coverage agreement (TWCC-81, TWCC- 82, TWCC-83, or TWCC-84), showing statutory workers' compensation insurance coverage for the person's or entity's (CONTRACTOR's) employees providing services on a Project, for the duration of the Project.

"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 OWNER.

"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.

- (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, § 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 OWNER 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 OWNER showing that coverage has been extended.
- (E) The CONTRACTOR shall obtain from each person providing services on a Project, and provide to the OWNER:
 - (1) a certificate of coverage, prior to that person beginning Work on the Project, so the OWNER will have on file certificates of coverage showing coverage for all persons providing services on the Project; and
 - (2) no later than seven (7) calendar 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 three (3) years thereafter.
- (G) The CONTRACTOR shall notify the OWNER in writing by certified mail or personal delivery, within ten (10) calendar 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 Workers' Compensation Commission, 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, § 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 three (3) years thereafter;
 - (6) notify the OWNER in writing by certified mail or personal delivery, within ten (10) calendar 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 clauses (I)-(1-7) of this subparagraph, 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 OWNER 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 Commission's Division of Self-Insurance Regulation. 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 OWNER to declare the

Contract void if the CONTRACTOR does not remedy the breach within ten (10) calendar days after receipt of notice of breach from the OWNER.

The liability limits shall not be less than:

Workmen's compensation	Texas Statutory Limits
Employer's liability	\$100,000.00 each occurrence

5.5.3 Comprehensive Business Automobile Liability. This insurance shall be written in comprehensive business form and shall protect the CONTRACTOR and the additional insureds against all claims described under Section 5.3.6. of the General Conditions of the Contract Documents and arising from the use of motor vehicles, and shall cover, on or off the Project site, all motor vehicles licensed for highway use, whether they are owned, non-owned, or hired.

The liability limits shall not be less than:

Bodily Injury and property damage	\$500,000.00 combined single limit each occurrence
-----------------------------------	--

5.5.4 Commercial General Liability. This insurance shall be an "occurrence" type policy written in commercial form and shall protect the CONTRACTOR and the additional insureds against all claims described in Sections 5.3.2., 5.3.3., 5.3.4., and 5.3.5. of the General Conditions of the Contract Documents arising out of any intentional or negligent act and/or omission of the CONTRACTOR or his agents, employees, or subcontractors. This policy shall also include protection against claims insured by usual personal injury liability coverage.

The liability limits shall not be less than:

Personal Injury and property damage	\$1,000,000.00 combined single limit each occurrence and \$1,000,000.00 aggregate
-------------------------------------	---

If the CONTRACTOR'S Work, or Work under his direction, requires blasting, explosive conditions, or underground operations, the commercial general liability coverage shall contain no exclusion relative to blasting, exploding, collapse of structures, or damage to underground property.

5.5.5 Excess Umbrella Liability Policy. This insurance shall protect the CONTRACTOR and the additional insureds against all claims in excess of the limits provided under the employer's liability, comprehensive business automobile liability, and commercial general liability policies. The liability limits of the umbrella policy shall not be less than \$2,000,000.00. The policy shall be an "occurrence" type policy.

5.5.6 Transportation Insurance. This insurance shall be of the "all risks" type and shall protect the CONTRACTOR and the OWNER from all insurable risks of physical loss or damage to equipment and materials in transit to the Project jobsite and until the OWNER receives

the equipment and materials at the Project jobsite. The coverage amount shall be not less than one-half of the full amount of the total Contract.

Transportation insurance shall provide for losses to be payable to the CONTRACTOR and the OWNER as their interests may appear.

5.5.7 All policies required under Section 5.5 herein shall contain a "cross liability" or "severability of interest" clause or endorsement. Notwithstanding any other provision of these policies, the insurance afforded shall apply separately to each insured, named insured, or additional insured with respect to any claim, suit, or judgment made or brought by or for any other insured, named insured, or additional insured, as though a separate policy had been issued to each, except the insurer's liability shall not be increased beyond the amount or amounts for which the insurer would have been liable had only one insured been named.

5.5.8 CONTRACTOR shall require each of his Subcontractors to procure and maintain during the life of his subcontract, Subcontractor's Commercial General Liability and Property Damage Insurance of the type specified in subparagraph 5.5.1, 5.5.2, 5.5.3, 5.5.4 and paragraph 5.6 hereof, in amounts approved by OWNER.

5.5.9 The insurance required under subparagraphs 5.5.2, 5.5.3, 5.5.4 and paragraph 5.6 hereof shall provide adequate protection for CONTRACTOR and his Subcontractors respectively against damage claims which may arise from operations under this Contract, whether such operation is by the insured or by anyone directly or indirectly employed by him, and also, against any special hazards which may be encountered in the performance of this Contract.

5.5.10 CONTRACTOR shall not commence any Work under this Contract until he has obtained all the insurance coverage required under this Article and such insurance has been approved by OWNER; nor shall CONTRACTOR allow any Subcontractor to commence Work on this Contract until the insurance required by the Subcontractor has been so obtained and approved.

Property Insurance:

5.6 Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall purchase and maintain property insurance upon the Work at the Project site to the full insurable value thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions, established by current customary construction industry standards given the type of Work and value thereof, or as may be required by Laws and Regulations). This insurance shall include the interests of OWNER, CONTRACTOR, and Subcontractors, in the Work, all of whom shall be listed as insured or additional insured parties, which shall insure against the perils of fire and extended coverage and shall include "all risk" insurance for physical loss and damage including theft, vandalism and malicious mischief, collapse and water damage, and such other perils as may be provided in the Supplementary Conditions; and shall include damages, losses and expenses arising out of or resulting from any insured loss or cost incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers, architects, attorneys and other professionals). If not covered under the "all risk" insurance or otherwise provided in the Supplementary Conditions, CONTRACTOR shall purchase and

maintain similar property insurance on portions of the Work stored on and off the site or in transit when such portions of the Work are to be included in an Application for Payment. The policies of insurance required to be purchased and maintained by CONTRACTOR in accordance with this paragraph shall be of an "occurrence"-type, when applicable, and contain a provision that the coverage afforded will not be canceled or materially changed until at least (30) thirty days prior written notice has been given to OWNER by certified mail.

5.6.1 Property Insurance Coverage. This insurance shall protect CONTRACTOR and the additional insureds against all claims described in Section 5.6 and shall provide the following minimum amounts:

Property Insurance Coverage: Provide Full Contract Amount or
\$100,000.00 Minimum, whichever is greater.

Waiver of Rights:

5.11 Waiver

5.11.1 CONTRACTOR waives all rights against OWNER, unless OWNER was solely negligent, for all losses and damages caused by any of the perils covered by the policies of insurance provided in response to paragraph 5.6 and any other property insurance applicable to the Work, and also waives all such rights against all other parties named as additional insureds in such policies for losses and damages so caused. As required by paragraph 6.11, each subcontract between CONTRACTOR and a Subcontractor will contain similar waiver provisions by the Subcontractor in favor of OWNER, and all other parties named as additional insureds.

5.11.2 CONTRACTOR intends that any policies provided in response to paragraph 5.6 shall protect all of the parties insured and provide primary coverage for all losses and damages caused by the perils covered thereby. Accordingly, all such policies shall contain provisions to the effect that in the event of payment of any loss or damage, the insurer will have no rights of recovery against any of the parties named as insured or additional insured, and if the insurers require separate waiver forms to be signed by any Subcontractor, CONTRACTOR will obtain the same.

Acceptance of Insurance:

5.14 If OWNER has any objection to the coverage afforded by or other provisions of the insurance required to be purchased and maintained by CONTRACTOR in accordance with paragraphs 5.3 and 5.4 on the basis of the coverages not complying with the Contract Documents, OWNER will attempt to notify CONTRACTOR in writing thereof within ten (10) calendar days of the date of delivery of such certificates to OWNER in accordance with paragraph 2.7. CONTRACTOR shall provide to the OWNER such additional information regarding the insurance provided by CONTRACTOR as the OWNER may reasonably request. Failure on the part of the OWNER or its agents to detect an insurance deficiency as compared to the insurance requirements of the Contract shall not constitute a waiver by the OWNER of the insurance requirements which CONTRACTOR and/or Subcontractor must contractually meet to be in compliance herewith.

Partial Utilization - Property Insurance:

5.15 If OWNER finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, such use or occupancy may be accomplished in accordance with paragraph 14.10. CONTRACTOR shall have the obligation to inform the insurers of OWNER's intent to so occupy or use a portion or portions of the Work. The insurers of CONTRACTOR providing the property insurance shall consent to such use or occupancy by endorsement on the policy or policies, but the property insurance shall not be canceled or lapse on account of any such partial use or occupancy by OWNER.

ARTICLE 6. CONTRACTOR'S RESPONSIBILITIES

Supervision and Superintendence:

6.1 CONTRACTOR shall supervise and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents and customary construction industry standards. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, procedures, safety and quality control of construction, but CONTRACTOR shall not be responsible for any negligence of others in any design or selection of a specific means, method, technique, sequence or procedure of construction which is indicated in and required by the Contract Documents. CONTRACTOR shall be solely responsible to guarantee that the finished Work complies accurately with the Contract Documents and CONTRACTOR shall not rely upon the OWNER's construction observation to accomplish same.

6.2 CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, who shall not be replaced without written notice to OWNER and ENGINEER, except under extraordinary circumstances. The superintendent will be CONTRACTOR's representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

Labor, Materials and Equipment:

6.3 CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the Work, oversee quality control, and perform construction of the Work as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the Project site. Except in connection with the safety or protection of persons or the Work or property at the Project site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the Project site shall be performed during regular daily working hours (generally eight (8) hours between 7:00 A. M. and 6:00 P.M.) as may be specifically set forth by the OWNER, and CONTRACTOR will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without OWNER's advanced written consent. Preference employment shall be given to resident citizens of the Cameron County, Texas area where such persons are available and fully qualified to perform the Work to which the employment relates.

6.3.1 CONTRACTOR shall acquaint himself with all matters and conditions

concerning the Project site and any existing construction. Any practical criticism or exception regarding any feature of the Work must be presented in writing to OWNER at least ten (10) calendar days prior to bidding. After a Contract agreement to perform the Work has been signed by CONTRACTOR, it shall then be his responsibility to provide satisfactory Work that will meet the full intent of the Contract Documents. CONTRACTOR shall then pursue this Work with the other trades so that all phases of the Work may be properly coordinated without delays or damage to any parts of the Work.

6.4 Unless otherwise specified in the General Requirements, CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

6.4.1 CONTRACTOR shall provide and maintain suitable weather-tight, washable, sanitary toilet facilities for all workmen for the entire construction period. CONTRACTOR shall comply with all requirements of applicable health authorities. When toilet facilities are no longer required, promptly remove from the Project site, disinfect and clean the area as required. CONTRACTOR shall keep toilet facility swept and supplied with toilet tissue at all times.

6.5 All materials and equipment shall be of good quality and new, except as otherwise specifically provided in the Contract Documents. Sometimes a project specification may require salvage and reinstallation of OWNER's recently acquired machinery and equipment pre-existing at a project site. If required by OWNER's Engineer, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment procured for the Project. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable Supplier, except as otherwise provided in the Contract Documents; but no provision of any such Supplier instructions will be effective to assign to OWNER any duty or authority to supervise or direct the furnishing or performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of paragraph 9.15 or 9.16.

6.6 CONTRACTOR shall notify OWNER in writing of any conflict between the manufacturer's directions and the Contract Documents and shall not perform any Work on any item until such conflict has been resolved. Upon award of the Contract, CONTRACTOR will secure a certificate of exemption from the Texas State Comptroller to preserve the CITY's exemption from Limited Sales, Excise and Use Tax in an amount representing that part of the total Contract price representative of the value of tangible personal property to be physically incorporated into the Project realty. The certificate of exemption must contain a statement to the effect that such materials or property have been, or will be, utilized in the performance of the Contract to the full extent of the amount for which a certificate of exemption is requested.

6.6.1 Except where otherwise specified, CONTRACTOR shall, at all times, provide protection against weather, so as to maintain all Work, materials and fixtures free from injury or damages. All new Work likely to be damaged shall be covered or otherwise protected as required.

6.6.2 While it is appreciated that CONTRACTOR has to maintain continuous construction operations and sequences, it should be understood that the OWNER's electric distribution system must function during the Contract period with a minimum of inconvenience to the electric users and the OWNER's water distribution system must function during the Contract period with a minimum of inconvenience to the water users, and that the OWNER'S sanitary sewer collection and treatment system must function during the Contract period on a 24 hour daily basis throughout the year to meet the requirements of the Texas Commission on Environmental Quality (TCEQ). It is therefore incumbent on CONTRACTOR to plan ahead on the basis of integrating his construction sequencing program as far as possible into the normal operating sequence of the utility systems. No departure from the normal operating sequence of the systems will be allowed, except with the specific advanced written agreement of OWNER.

6.6.3 CONTRACTOR shall notify OWNER a minimum of 48 hours in advance of any Work which will be tied into the existing utility systems. Method of tie-in shall be submitted to OWNER for OWNER's approval prior to any Work being performed. At no time shall contaminated water that has not been disinfected be allowed to seep into the existing waterlines, and at no time shall sewage be allowed to flow into surrounding areas. Connections will be made during times of daily minimum sewage flows, if required by Project.

6.6.4 CONTRACTOR shall coordinate his Work with that of other contractors whose work may occur at a conflicting time and location. The coordination shall be such that CONTRACTOR's Work will be maintained at a normal rate.

6.6.5 All Work that is performed on, across or along International Boundary and Water Control Commission levees must conform to all I.B. & W.C.C. requirements. All Work performed on, across or along Brownsville Irrigation and Drainage District or the Cameron County Water Control and Improvement District No.16 canals or ditches must conform to all District requirements.

6.6.6 Satisfactory access or detour roads shall be provided where necessary due to construction.

6.6.7 If required by the Bid or Project Specifications, or by law for the type of excavation construction being performed, CONTRACTOR and his Registered Professional Engineer shall develop the Trench Safety System Plan and shall provide any necessary shoring, bracing and/or sheeting pursuant to Section 756.022 of the Texas Health and Safety Code and OSHA 29 C.F.R. 1926, Subpart P, Vol. 54 No. 209 of the Federal Register, October 31, 1989, pp. 45959-45991, and, as provided in Section 11 - "Trench Excavation and Shoring Safety Plan" of the Standard Specifications.

6.6.8 CONTRACTOR shall provide adequate barricades and warning devices in conformance with the guidelines for Traffic Control as established by the Texas Department of Transportation (TDOT) in the Texas Manual on Uniform Traffic Control Devices (TMUTCD). This provision shall be subsidiary to the rest of the Work in this Contract, and shall not constitute a separate pay item.

6.6.9 CONTRACTOR shall provide the services of a technical representative for CONTRACTOR furnished equipment, for a sufficient period of time to assist in start-up and initial adjustment of all equipment, and to train, advise and consult with OWNER's operating personnel, if appropriate for the Project.

6.6.10 All items of equipment required for this Contract shall be bid to provide as part of the initial price, any literature explaining "Operation and Maintenance" of that item of equipment, if required by Project. If a manufacturer does not print such a standard O&M manual, CONTRACTOR shall provide OWNER with a customized manual approved, in writing by the manufacturer.

Adjusting Progress Schedule:

6.7 CONTRACTOR shall submit to OWNER's Engineer for acceptance (to the extent indicated in paragraph 2.9) adjustments in the Progress Schedule to reflect the impact thereon of new developments; these will conform generally to the Progress Schedule then in effect and additionally will comply with any provisions of the General Requirements applicable thereto.

Substitutes or "Or-Equal" Items:

6.8

6.8.1 Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item, or the name of a particular Supplier, the naming of the item is intended to establish the type, function, performance standard and quality required. In some instances, the OWNER is legally allowed to "sole source" a specific material or component of equipment when its design and/or performance is required to integrate with a larger system that will remain in place. Unless the material or equipment name is followed by words indicating that no substitution is permitted, materials or equipment of other Suppliers generally may be accepted by OWNER's Engineer, if sufficient information is submitted by CONTRACTOR to allow OWNER's Engineer to determine that the material or equipment proposed is equivalent, or equal to, that named by OWNER. The procedure for review by OWNER's Engineer will include the following as supplemented in the General Requirements. Requests for review of substitute items of material and equipment will not be accepted by OWNER's Engineer from anyone other than CONTRACTOR. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall make written application to OWNER's Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified. The application will state that the evaluation and acceptance of the proposed substitute will not prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with OWNER for any other work on the Project by other contractors) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified will be

identified in the application and available maintenance, repair and replacement parts and service will be indicated. The application will also contain an itemized estimate of all costs or savings that will result directly or indirectly from acceptance of such substitute, including costs of redesign and potential claims of other contractors affected by the resulting change, all of which shall be considered by OWNER's Engineer in evaluating the proposed substitute. OWNER's Engineer may require CONTRACTOR to furnish at CONTRACTOR's expense additional data about the proposed substitute.

6.8.2 If a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents, CONTRACTOR may generally furnish or utilize a substitute means, method, sequence, technique or procedure of construction acceptable to OWNER's Engineer, if CONTRACTOR submits sufficient information to allow OWNER's Engineer to determine that the substitute proposed can be legally utilized by CONTRACTOR (e.g. patented or licensed processes) and is equivalent to that indicated or required by the Contract Documents. OWNER may have similar legal rights to "sole source" as indicated above in paragraph 6.8.1. The procedure for review by OWNER's Engineer will be similar to that provided in paragraph 6.8.1 above, as applied by OWNER's Engineer and as may be supplemented in the General Requirements.

6.8.3 OWNER's Engineer will be allowed a reasonable time within which to evaluate each proposed substitute. OWNER's Engineer will be the sole judge of acceptability, and no substitute will be ordered, installed or utilized without OWNER's Engineer prior written acceptance which will be evidenced by either a Change Order or an approved Shop Drawing. OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guaranty or other form of surety with respect to any substitute. OWNER's Engineer will record time required by OWNER's Engineer and any OWNER'S Engineer outside technical consultants in evaluating substitutions proposed by CONTRACTOR and in making changes in the Contract Documents occasioned thereby. Whether or not OWNER's Engineer accepts a proposed substitute, CONTRACTOR shall reimburse OWNER for the charges of OWNER's Engineer and any consultants for evaluating each proposed substitute.

Concerning Subcontractors, Suppliers and Others:

6.9

6.9.1 CONTRACTOR shall not employ any Subcontractor, Supplier or other person or organization (including those acceptable to OWNER as indicated in paragraph 6.8.2), whether initially or as a substitute, against whom OWNER may have reasonable objection. CONTRACTOR shall not be required to employ any Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection.

6.9.2 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers or other persons or organizations (including those who are to furnish the principal items of material and equipment), to be submitted to OWNER in advance of a specified date prior to the Effective Date of the Agreement for acceptance by OWNER, and if CONTRACTOR has submitted a list thereof in accordance with the Supplementary Conditions, OWNER's acceptance (either in writing or by failing to make written objection thereto by the date

indicated for acceptance or objection in the bidding documents or the Contractor Documents) of any such Subcontractor, Supplier or other person or organization so identified may be revoked by OWNER on the basis of reasonable objection after due investigation, in which case CONTRACTOR shall submit an acceptable substitute. The Contract Price may be increased by the difference in the cost occasioned by such substitution and an appropriate Change Order may be issued or Written Amendment signed. All increases or decreases in the Contract Price shall be governed by all State and local statutes, codes, laws, ordinances, rules and regulations governing public competitive bidding and Change Orders. No acceptance by OWNER of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of OWNER to reject any defective or noncompliant Work.

6.10 CONTRACTOR shall be fully responsible to OWNER for all acts and/or omissions of the Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct contract or indirect relationship with CONTRACTOR, just as CONTRACTOR is responsible to the OWNER for CONTRACTOR's own acts and/or omissions. Nothing in the Contract Documents shall create any contractual relationship between OWNER and any such Subcontractor, subtier subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of OWNER to pay or to supervise the payment of any moneys due any such Subcontractor, subtier subcontractor, Supplier or other person or organization, except as may otherwise be required by Laws and Regulations.

6.11 The divisions and sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.12 All Work performed for CONTRACTOR by a Subcontractor will be pursuant to an appropriate written agreement between CONTRACTOR and the Subcontractor, which specifically binds the Subcontractor through appropriate "flow down" provisions, to the applicable terms and conditions of the Contract Documents for the benefit of OWNER, and contains waiver provisions as required by paragraph 5.11.

Patent Fees and Royalties:

6.13 CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device, which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work, and if to the actual knowledge of OWNER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. **CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER AND ANYONE DIRECTLY OR INDIRECTLY EMPLOYED BY OWNER AGAINST ANY CLAIMS, DAMAGES, LOSSES AND EXPENSES (INCLUDING ATTORNEYS' FEES AND COURT COSTS) ARISING OUT OF ANY INFRINGEMENT OF PATENT RIGHTS OR COPYRIGHTS INCIDENT TO THE USE IN THE PERFORMANCE OF THE WORK OR RESULTING FROM THE INCORPORATION IN THE WORK OF ANY INVENTION, DESIGN, PROCESS, PRODUCT OR DEVICE NOT SPECIFIED IN THE**

CONTRACT DOCUMENTS, AND SHALL DEFEND ALL SUCH CLAIMS IN CONNECTION WITH ANY ALLEGED INFRINGEMENT OF SUCH RIGHTS. IT IS THE EXPRESSED INTENTION OF THE PARTIES HERETO THAT THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH IS INDEMNITY BY CONTRACTOR TO INDEMNIFY AND PROTECT OWNER FROM THE CONSEQUENCES OF OWNER'S OWN NEGLIGENCE WHERE THAT NEGLIGENCE ON THE PART OF THE OWNER IS A CONCURRING CAUSE OF THE CLAIMS, DAMAGES, LOSSES, AND EXPENSES REFERENCED ABOVE. FURTHERMORE, THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH SHALL HAVE NO APPLICATION TO ANY CLAIM, DAMAGE, LOSS AND EXPENSE REFERENCED ABOVE WHERE SUCH RESULTS FROM THE SOLE NEGLIGENCE OF THE OWNER INDEPENDENT OF THE FAULT OF ANY OTHER PERSON OR ENTITY.

Permits:

6.14 Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids. CONTRACTOR shall pay all charges of utility owners for connections to the Work, and OWNER shall pay all charges of such utility owners for capital costs related thereto such as impact fees or plant investment fees, if any.

6.14.1 Fires shall not be built on the Project premises except by the express consent of OWNER and Brownsville City Fire Marshall.

Laws and Regulations:

6.15

6.15.1 CONTRACTOR shall give all notices and comply with all Laws and Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, OWNER shall not be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations.

6.15.2 If CONTRACTOR has actual knowledge that the Specifications or Drawings are at variance with any Laws or Regulations, CONTRACTOR shall give OWNER's Engineer prompt written notice thereof, and any necessary changes will be authorized by OWNER by one of the methods indicated in paragraph 3.4. If CONTRACTOR performs any Work knowing, or having reason to know, that it is contrary to such Laws or Regulations, and without such notice to OWNER's Engineer, CONTRACTOR shall bear all costs arising there from; however, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Drawings are in accordance with such Laws and Regulations.

Taxes:

6.16 "Pursuant to 34 Texas Administrative Code 3.291, in order for the OWNER to

continue to benefit from its status as a State Sales and Use Tax Exempt Organization, after August 14, 1991 construction contracts must be awarded on a "separated contract" basis. A "separated contract" is one that distinguishes the value of the tangible personal property (materials such as pipe, bricks, lumber, concrete, paint, etc.) to be physically incorporated into the Project from the total Contract price. Under the "separated contract" format, the CONTRACTOR in effect becomes a "seller" to the OWNER of materials that are to be physically incorporated into the Project realty. As a "seller", the CONTRACTOR will issue a "Texas Certificate of Resale" to the supplier in lieu of paying the sales tax on materials at the time of purchase. The CONTRACTOR will also issue a "Certificate of Exemption" to the supplier, demonstrating that the personal property is being purchased for resale and that the resale is to a public owner, the City of Brownsville, Texas, and its BPUB, which are sales tax exempt entities under UTCA Tax Code Section 151.309(5). CONTRACTOR should be careful to consult the most recent guidelines of the State Comptroller of Public Accounts regarding the sales tax status of supplies and equipment that are used and consumed during Project Work, but that are not physically incorporated into the Project realty. If the CONTRACTOR has questions about the implementation of this policy he is asked to inquire with the State Comptroller of Public Accounts, Tax Administration Division, State of Texas, Austin, Texas 78774. The CONTRACTOR will not include any federal taxes in bid prices since the OWNER is exempt from payment of such taxes. "Texas Certificates of Exemption", "Texas Certificates of Resale" and "Texas Sales Tax Permits" are forms available to the CONTRACTOR through the regional offices of the Texas State Comptroller of Public Accounts."

Use of Premises:

6.17 CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workers to the Project site and land and areas identified in and permitted by the Contract Documents, or otherwise privately acquired by the CONTRACTOR, and other land and areas permitted by Laws and Regulations, rights-of-way, permits and easements. CONTRACTOR shall assume full responsibility for any damage to any Project land or area, or to the owner or occupant thereof, or of any land or areas contiguous thereto, resulting from the performance of the Work. Should any claim be made against OWNER by any such adjacent owner or occupant because of the performance of the Work, CONTRACTOR shall promptly attempt to settle with such other party by agreement, or otherwise resolve the claim by mediation, arbitration or at law. **CONTRACTOR SHALL, TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, INDEMNIFY, AND HOLD HARMLESS OWNER FROM AND AGAINST ALL CLAIMS, DAMAGES, LOSSES AND EXPENSES (INCLUDING, BUT NOT LIMITED TO, FEES OF ENGINEERS, ARCHITECTS, ATTORNEYS AND OTHER PROFESSIONALS AND COURT COSTS) ARISING DIRECTLY, INDIRECTLY OR CONSEQUENTIALLY OUT OF ANY ACTION, LEGAL OR EQUITABLE, BROUGHT BY ANY SUCH OTHER PARTY AGAINST OWNER, TO THE EXTENT BASED ON A CLAIM ARISING OUT OF CONTRACTOR'S PERFORMANCE OF THE WORK. IT IS THE EXPRESSED INTENT OF THE PARTIES HERETO THAT THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH IS INDEMNITY BY CONTRACTOR TO INDEMNIFY AND PROTECT OWNER FROM THE CONSEQUENCES OF OWNER'S OWN NEGLIGENCE, WHEN THAT NEGLIGENCE ON THE PART OF THE OWNER IS A CONCURRING CAUSE OF THE INJURY, DEATH OR DAMAGE.**

FURTHERMORE, THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH SHALL HAVE NO APPLICATION TO ANY CLAIM, LOSS, DAMAGE, CAUSE OF ACTION, SUIT, AND LIABILITY WHERE THE INJURY, DEATH OR DAMAGE RESULTS FROM THE SOLE NEGLIGENCE OF THE OWNER, INDEPENDENT OF THE FAULT OF ANY OTHER PERSON OR ENTITY.

6.18 During the progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work, CONTRACTOR shall remove and legally dispose of all waste materials, rubbish and debris from and about the premises, as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the Project site clean and ready for occupancy by OWNER. CONTRACTOR shall restore to original condition all property not designated for alteration by the Contract Documents.

6.19 CONTRACTOR shall be confined to all working easements provided by OWNER, unless CONTRACTOR separately and privately secures at his own cost, additional private temporary construction easements. Generally, storage of excavation material and all CONTRACTOR equipment and material shall remain within the limits of Project working easements.

6.20 CONTRACTOR shall not weight load or permit any part of any structure or utility to be loaded in any manner that will endanger the structure or utility, nor shall CONTRACTOR subject any part of the Work or adjacent property to surcharge stresses or pressures, or loss of subjacent or lateral support, that will endanger it.

Record Documents:

6.21 CONTRACTOR shall as a precondition to interim progress payments, regularly maintain and update and store in a safe place at the Project site, one record copy of all Drawings, Specifications, Addenda, Written Amendments, Change Orders, Work Directive Changes, Field Orders and any written interpretations and clarifications (issued pursuant to paragraph 9.4) in good order and periodically annotated to show all changes made by CONTRACTOR during construction. These periodically updated record documents, together with all approved samples and a counterpart of all approved Shop Drawings, will be at all times available to OWNER's Engineer for reference. Upon completion of the Work, these record documents, samples and Shop Drawings, will be delivered to OWNER's Engineer for OWNER record retention.

Safety and Protection:

6.22 CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of employees and the general public, and shall provide the necessary protection to prevent damage, injury or loss to:

6.22.1 all employees on the Work and other persons and organizations who may be required to properly visit the Project site and be affected thereby;

6.22.2 all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Project site; and

6.22.3 other property at the Project site or adjacent thereto, including drainage gradients, trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and underground facilities not designated for removal, relocation or replacement in the course of construction.

6.22.4 Driveways, culverts, storm sewer inlets and laterals, and other public or private property that is destroyed or removed during the construction shall be replaced to its original or better condition by CONTRACTOR. Temporary drainage and any subgrade dewatering is to be provided by CONTRACTOR as necessary to protect and complete the Work.

6.22.5 CONTRACTOR is responsible for locating any underground obstacles. It is not represented that the Plans show all previous or current sewers, waterlines, electric lines, gas lines, telephone lines and other underground obstacles and utilities. CONTRACTOR shall exercise caution to prevent damage to existing utility facilities during the progress of the construction Work, taking care to locate same in advance of the actual Work. OWNER will render all assistance possible to CONTRACTOR in the matter of determining the location of existing utilities by making available such existing maps, records, and other available existing information as may be accessible to OWNER, when requested to do so, but the accuracy of such information will not be guaranteed by OWNER. CONTRACTOR shall make repairs and/or replacements to all damage to existing utilities resulting from his operations. Where a pipe, duct or other structure of a utility is exposed, which, in the opinion of OWNER requires strengthening, altering or moving, CONTRACTOR shall perform such Work on same, as OWNER may order, which Work may be paid for as extra Work. Should CONTRACTOR, in the layout of his Work, encounter any pipe, underground utility or structure, the location of which has been furnished to him by OWNER, he shall bring such conditions to the attention of OWNER for OWNER and CONTRACTOR discussion to determine the CONTRACTOR'S method to be used to pin in place, remove or bypass such obstructions.

6.22.6 It is essential that in the event of any damage being caused to existing utilities that immediate attention be given to their repair. Any repair work carried out shall be at the cost of CONTRACTOR and shall be performed to the complete satisfaction of OWNER, who will acknowledge same in writing. It is therefore, the duty of CONTRACTOR, prior to the commencement of construction, to inspect and accurately record in writing to OWNER, the condition of any utility which he reasonably suspects or knows to be damaged, faulty, or defective. In addition, any such utilities so recorded, which in the opinion of CONTRACTOR may deteriorate further as a result of the proposed mode of construction operations, should be protected, and/or other remedial measures employed as agreed to with OWNER.

CONTRACTOR shall comply with all applicable Laws and Regulations of any public body having jurisdiction for the safety of persons or property, or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and utility owners, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, restoration and replacement of their property. All damage, injury or loss to any property referred to in paragraph 6.20.2 or 6.20.3 caused, directly or indirectly, in

whole or in part by CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work; or anyone for whose acts any of them may be liable; shall be remedied by CONTRACTOR. CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and OWNER'S Engineer has issued a notice to OWNER and CONTRACTOR in accordance with paragraph 14.13 that the Work is acceptable to OWNER (except as otherwise expressly provided in connection with Substantial Completion).

6.23 CONTRACTOR shall designate in writing to OWNER a responsible representative at the Project site whose duty shall be the management of risk and safety, and that person shall make a concerted effort to assist workers and visitors at the Project site to prevent accidents. This person shall be CONTRACTOR's superintendent, unless otherwise designated in writing by CONTRACTOR to OWNER.

Emergencies:

6.24 In emergencies affecting the safety or protection of persons, or the Work, or property at the Project site or adjacent thereto, CONTRACTOR, without special written or oral instruction or authorization from OWNER, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give OWNER's Engineer prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If OWNER's Engineer determines that a change in the Contract Documents is required because of the CONTRACTOR's prompt action taken in response to an emergency, a Work Directive Change or Change Order will be issued to document the consequences of any changes or variations.

Shop Drawings and Samples:

6.25 After checking and verifying all field measurements and after complying with applicable procedures specified in the General Requirements, CONTRACTOR shall submit to OWNER's Engineer for review and approval, in accordance with the accepted Schedule of Shop Drawing submissions (see paragraph 2.9), or for other appropriate action if so indicated in the Supplementary Conditions, five (5) copies (unless otherwise specified in the General Requirements) of all Shop Drawings, which will bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's responsibilities under the Contract Documents with respect to the internal review of the submission. All submissions will be identified as the OWNER's Engineer may require. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to enable OWNER'S Engineer to efficiently and comprehensively review the CONTRACTOR's information as required.

6.25.1 Before ordering any material or doing any Work, CONTRACTOR will verify all measurements of any existing and new Work and shall be responsible for their correctness. Any differences which may be found shall be submitted to OWNER for consideration before proceeding with the Work. No extra compensation will be allowed to CONTRACTOR because of differences between actual dimensions and measurements indicated on the final working drawings.

6.26 CONTRACTOR shall also submit to OWNER's Engineer for review and approval with such promptness as to cause no delay in Work, all samples required by the Contract Documents. All samples will have been checked by and accompanied by a specific written indication that CONTRACTOR has internally satisfied CONTRACTOR's responsibilities under the Contract Documents with respect to the review of the submission, and will be identified clearly as to material, Supplier, pertinent data such as catalog numbers and the use for which intended.

6.27

6.27.1 Before submission of each Shop Drawing or sample, CONTRACTOR shall have internally determined and verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each Shop Drawing or sample with other Shop Drawings and samples, and with the requirements of the Work and the Contract Documents.

6.27.2 At the time of each submission, CONTRACTOR shall give OWNER's Engineer specific written notice of each variation that the Shop Drawings or samples may have from the requirements of the Contract Documents, and, in addition, shall cause a specific notation to be made on each Shop Drawing submitted to OWNER's Engineer for review and approval, of each such CONTRACTOR variation.

6.28 OWNER's Engineer will review and approve with reasonable promptness, Shop Drawings and samples, but OWNER Engineer's review and approval will be only for general conformance with the design concept of the Project and for compliance with the information given in the Contract Documents, and shall not extend to CONTRACTOR's means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents), or to CONTRACTOR's safety precautions or programs incident thereto. The review and approval of a separate or component item will not indicate approval of the assembly into which the item functions integrally. CONTRACTOR shall make corrections required by OWNER's Engineer, and shall return the required number of corrected copies of Shop Drawings and submit as required, new samples for review and approval. CONTRACTOR shall direct Owner Engineer's specific attention in writing to the most current revisions, other than the corrections called for by OWNER's Engineer on previous CONTRACTOR submittals.

6.29 OWNER Engineer's review and approval of Shop Drawings or samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents, unless CONTRACTOR has in writing called OWNER Engineer's attention to each such variation at the time of submission as required by paragraph 6.25.2, and OWNER's Engineer has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Shop Drawing or sample approval; nor will any approval by OWNER's Engineer relieve CONTRACTOR from responsibility for CONTRACTOR's errors or omissions in the Shop Drawings, or from responsibility for having complied with the provisions of paragraph 6.25.1.

6.30 Where a Shop Drawing or sample is required by the Specifications, any related

Work performed prior to OWNER Engineer's review and approval of the pertinent submission will be at the sole risk, expense and responsibility of CONTRACTOR.

Continuing the Work:

6.31 CONTRACTOR shall carry on the Work and adhere to the Progress Schedule during any and all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as OWNER may otherwise agree in writing.

INDEMNIFICATION:

6.32 CONTRACTOR AGREES TO AND SHALL INDEMNIFY AND HOLD HARMLESS OWNER, ITS PUBLIC OFFICIALS, OFFICERS, BOARD MEMBERS, AND EMPLOYEES, FROM AND AGAINST ANY AND ALL CLAIMS, LOSSES, DAMAGES, CAUSES OF ACTION, SUITS, AND LIABILITY OF EVERY KIND, INCLUDING ALL EXPENSES OF LITIGATION, COURT COSTS, AND ATTORNEY'S FEES, FOR INJURY TO OR DEATH OF ANY PERSON, OR FOR DAMAGE TO ANY PROPERTY, ARISING OUT OR IN CONNECTION WITH THE PERFORMANCE OF THE WORK, PROVIDED THAT SUCH CLAIM, DAMAGE, LOSS, LIABILITY OR EXPENSE (A) IS ATTRIBUTABLE TO BODILY INJURY, SICKNESS, DISEASE OR DEATH OR TO INJURY OR DESTRUCTION OF TANGIBLE PROPERTY, INCLUDING THE LOSS OF USE RESULTING THERE FROM AND (B) IS CAUSED IN WHOLE OR IN PART BY ANY CONDITION OF THE WORK OR MATERIALS, OR BY ANY NEGLIGENT ACT OR OMISSION OF CONTRACTOR, ANY SUBTIER SUBCONTRACTOR, ANYONE DIRECTLY OR INDIRECTLY EMPLOYED BY CONTRACTOR OR ANY SUBCONTRACTOR OR ANYONE FOR WHOSE ACTS CONTRACTOR OR ANY SUBCONTRACTOR MAY BE LIABLE UNDER THIS CONTRACT.

SUCH INDEMNITY SHALL APPLY WHERE THE CLAIMS, LOSSES, DAMAGES, CAUSES OF ACTION, SUITS, OR LIABILITY ARISE IN PART FROM THE CONCURRENT NEGLIGENCE OF OWNER.

IT IS THE EXPRESSED INTENTION OF THE PARTIES HERETO, BOTH CONTRACTOR AND OWNER, THAT THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH IS INDEMNITY BY THE CONTRACTOR, TO INDEMNIFY AND PROTECT OWNER FROM THE CONSEQUENCES OF OWNER'S OWN NEGLIGENCE, WHERE THAT NEGLIGENCE IS A CONCURRING CAUSE OF THE INJURY, DEATH OR DAMAGE. FURTHERMORE, HOWEVER, THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH SHALL HAVE NO APPLICATION TO ANY CLAIM, LOSS, DAMAGE, CAUSE OF ACTION, SUIT, AND LIABILITY WHERE THE INJURY OR DEATH OR DAMAGE RESULTS FROM THE SOLE NEGLIGENCE OF THE OWNER, INDEPENDENT OF THE FAULT OF ANY OTHER PERSON OR ENTITY.

6.33 IN ANY AND ALL CLAIMS AGAINST OWNER OR ANY OF ITS CONSULTANTS, AGENTS OR EMPLOYEES BY ANY EMPLOYEE OF

CONTRACTOR, ANY SUBCONTRACTOR, ANY PERSON OR ORGANIZATION DIRECTLY OR INDIRECTLY EMPLOYED BY ANY OF THEM TO PERFORM OR FURNISH ANY OF THE WORK, OR ANYONE FOR WHOSE ACTS ANY OF THEM MAY BE LIABLE, THE INDEMNIFICATION OBLIGATION UNDER PARAGRAPH 6.32 SHALL NOT BE LIMITED IN ANY WAY BY ANY LIMITATION ON THE AMOUNT OR TYPE OF DAMAGES, COMPENSATION OR BENEFITS PAYABLE BY OR FOR CONTRACTOR, OR ANY SUCH SUBCONTRACTOR, OR OTHER PERSON OR ORGANIZATION UNDER WORKERS' OR WORKMEN'S COMPENSATION ACTS, DISABILITY BENEFIT ACTS OR OTHER EMPLOYEE BENEFIT ACTS.

6.34 THE OBLIGATIONS OF CONTRACTOR UNDER PARAGRAPH 6.32 SHALL NOT EXTEND TO ANY LIABILITY OF OWNER, OWNER'S ENGINEER, CONSULTANTS, AGENTS OR EMPLOYEES ARISING OUT OF THE PREPARATION OR APPROVAL OF PROJECT MAPS, DRAWINGS, PLANS, OPINIONS, REPORTS, SURVEYS, CHANGE ORDERS, DESIGNS, OR SPECIFICATIONS.

6.35 CONTRACTOR shall perform all phases of Work, other than general clean-up, thru the duration of the Contract, as defined in these General and any Supplementary General Conditions. If CONTRACTOR desires to perform Work, other than general clean-up during holidays, prior proper arrangements must be made in writing with OWNER, or any other regulatory agency regarding such Work.

6.35.1 General. This Contract shall be based upon payment by CONTRACTOR and his Subcontractors of wage rates not less than the General Prevailing Wage Rate of per diem wages for work of a similar character in Cameron County, Texas, for each type of laborer, workman or mechanic needed to implement the Contract at the Project Site, and not less than the general prevailing rate of per diem wages for legal holiday and overtime Work. The Schedule of General Prevailing Wage Rates specifically adopted by the OWNER for this Project, and other important Wage and Labor Standard Provisions are included in these Contract Documents in the Supplementary General Conditions. Pursuant to local BPUB labor policy, no Project worker shall be paid less than \$8.00 per hour, regardless of the adopted wage listings in the attached U. S. Department of Labor General Wage Decision.

CONTRACTOR shall at minimum comply with all requirements of the prevailing wage law of the State of Texas, Texas Revised Civil Statutes, Texas Government Code Section 2259.001 et seq., including the latest amendments thereto, and those special local wage provisions adopted by OWNER. When in conflict , the more stringent requirements apply to CONTRACTOR.

6.35.2 Records. CONTRACTOR and each Subcontractor shall keep an accurate record showing the names and occupations of all classifications of laborers, workmen, and mechanics employed, together with the actual wages paid to each worker. At all reasonable working hours, such records shall be open to inspection by the representatives of the OWNER. With each application for payment, CONTRACTOR shall provide a certified copy of such payroll records as necessary to substantiate compliance with this provision during the period of time for which the application for payment pertains. OWNER shall take cognizance of any and all employee complaints regarding any violations of the requirements of TGC Section 2259.001 et

seq.

6.35.3 Penalty. In case CONTRACTOR and any Subcontractor fail to comply with the prevailing wage law, by statutory authority, CONTRACTOR shall forfeit to the OWNER \$60.00 per calendar day, or portion thereof, for each laborer, workman, or mechanic who is paid less than the specified local rate for any Work done under the Contract.

6.35.4 Hours of Labor. CONTRACTOR shall comply with all requirements of the hours of work on public works in accordance with the laws of the State of Texas, Texas Revised Civil Statutes, Articles 5165.1 to 5165.3, including the latest amendments thereto.

No CONTRACTOR or Subcontractor contracting for any part of the Contract Work which may require or involve the employment of laborers, workmen or mechanics at the Project Site, shall require or permit any laborer, workman or mechanic in any work week in which he is employed on such Work, to work in excess of forty (40) hours in such work week, unless such laborer, workman or mechanic receives compensation at a rate not less than one and one-half times his basic rate of pay, for all hours in excess of forty (40) hours in such work week.

6.35.5 Equal Employment Opportunities. The CONTRACTOR shall not discriminate against any employee or applicant for employment because of race, religion, gender, sexual preference, national origin, age, physically challenged condition, or a political belief or affiliation, and will comply with all State and federal statutes applicable to CONTRACTOR which relate to employment discrimination.

ARTICLE 7. OTHER WORK

Related Work at Site:

7.1 OWNER may perform other separate work related to the Project at the site by OWNER's own forces, have other work performed by utility owners, or award other direct construction contracts therefor, which shall contain General Conditions similar to these. If the fact that such other work is to be performed was not originally noted in these Contract Documents, advance written notice thereof will be given to CONTRACTOR prior to OWNER authorizing any such other work; and, if CONTRACTOR believes that such other work performance will involve additional expense to CONTRACTOR, or requires additional time, and the parties are unable to agree as to the extent thereof, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12. All increases or decreases in the Contract price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

7.2 CONTRACTOR shall afford each utility owner and other contractor who is a party to a direct contract with OWNER (or OWNER, if OWNER is performing the additional work with OWNER's employees) proper and safe access to the Project site and a reasonable opportunity for the introduction and storage of materials and equipment, and the execution of such work, and shall properly connect and coordinate the Work with their separate work. CONTRACTOR shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any

work of others by cutting, excavating or otherwise altering their work, and will only cut or alter their work with the written consent of OWNER's Engineer and the consent of other contractor(s), persons whose work will be affected. The duties and responsibilities of CONTRACTOR under this paragraph are for the benefit of such utility owners and other contractors, to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between OWNER and such other utility owners and other contractors.

7.3 If any part of CONTRACTOR's Work depends for proper execution or results upon the work of any such other contractor or utility owner (or OWNER), CONTRACTOR shall inspect and promptly report to OWNER's Engineer in writing any delays, defects or deficiencies in such other work that renders it unavailable or unsuitable for such integration, proper execution and results. CONTRACTOR's failure so to report will constitute an acceptance of the other work as fit and proper for integration with CONTRACTOR's Work, except for latent or non-apparent defects and deficiencies in the other work.

Coordination:

7.4 If OWNER contracts with others for the performance of other work on the Project at the Project site, the person or organization who will have authority and responsibility for coordination of the activities among the various prime contractors will be identified by OWNER in the Supplementary Conditions, and the specific matters to be covered by such authority and responsibility will be itemized, and the extent of such authority and responsibilities will be provided, in the Supplementary Conditions.

ARTICLE 8. OWNER'S RESPONSIBILITIES

8.1 OWNER shall issue all written and oral communications to CONTRACTOR through OWNER's Field Representative and/or OWNER's Engineer.

8.2 In case of termination of the employment of OWNER's Engineer, OWNER shall appoint a replacement Engineer whose status under the Contract Documents shall be that of the former Engineer.

8.3 OWNER shall furnish the data required of OWNER under the Contract Documents promptly, and shall make eligible payments to CONTRACTOR within the time periods allowed by the Contract Documents and State prompt pay statutes, after payments are due as provided in paragraphs 14.4 and 14.13.

8.4 OWNER's duties in respect to providing lands and easements and providing any recent existing available engineering surveys to establish CONTRACTOR construction reference points, are set forth in paragraphs 4.1 and 4.4. Paragraph 4.2 refers to OWNER's identifying and making available to CONTRACTOR copies of any existing and available reports of explorations and tests of subsurface pre-existing conditions at the Project site which are not part of the Contract Documents, but which have been utilized by OWNER's Engineer in generally preparing the Drawings and Specifications.

8.5 (RESERVED)

8.6 OWNER is obligated to execute Change Orders as indicated in paragraph 10.4.

8.7 OWNER's responsibility in respect to certain inspections, tests and approvals is set forth in paragraph 13.4.

8.8 In connection with OWNER's right to stop Work or suspend Work, see paragraphs 13.10 and 15.1. Paragraph 15.2 outlines OWNER's right to terminate services of CONTRACTOR under certain circumstances.

ARTICLE 9. OWNER ENGINEER'S STATUS DURING CONSTRUCTION

Owner's Representative:

9.1 OWNER's Engineer will be OWNER's primary representative during the construction period.

Visits to Site:

9.2 OWNER's Engineer will make periodic visits to the site at intervals appropriate to the various stages of construction to observe the progress and general quality of the executed Work and to determine, in general, for the benefit of OWNER only, if the Work is proceeding in accordance with the Contract Documents. OWNER's Engineer will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work, because CONTRACTOR is solely responsible for same. OWNER Engineer's efforts will be directed toward providing for OWNER only, a greater degree of confidence that the CONTRACTOR's completed Work will conform to the Contract Documents. On the basis of such limited visits and on-site observations as an experienced and qualified design professional working for OWNER, OWNER's Engineer will keep OWNER informed of the progress of the Work and will endeavor to advise OWNER of any obvious defects and deficiencies in the Work.

On-Site Project Representation:

9.3 OWNER may furnish a Project Field Representative to assist OWNER's Engineer in observing the daily performance of the Work. This is an option available to OWNER that need not be exercised, nor may it be relied upon by the CONTRACTOR in any way to satisfy CONTRACTOR's quality control responsibility. The duties, responsibilities and limitations of authority of any such Project Field Representative and assistants will be determined by the OWNER.

Clarifications and Interpretations:

9.4 OWNER's Engineer will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as OWNER's Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. If CONTRACTOR believes that a written clarification or interpretation by OWNER's Engineer

justifies an increase in the Contract Price or an extension of the Contract Time, and the OWNER and CONTRACTOR are unable to agree to the basis, amount or extent thereof, CONTRACTOR may make a claim therefore as provided in Article 11 or Article 12. Any increases or decreases in the Contract Price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Authorized Variations in Work:

9.5 OWNER's Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Time, and are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and will be binding on OWNER, and also on CONTRACTOR who shall perform the Work involved promptly. If CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Time, CONTRACTOR may make a claim therefore as provided in Article 11 or 12. Any increases or decreases in the Contract Price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Rejecting Defective Work:

9.6 OWNER's Engineer will have the authority to disapprove or reject Work which OWNER's Engineer believes to be defective, and will also have authority to require special inspection or testing of the Work as provided in paragraph 13.9, whether or not the Work is fabricated, installed or completed.

Shop Drawings, Change Orders and Payments:

9.7 In connection with OWNER Engineer's responsibility for Shop Drawings and samples, see paragraphs 6.23 through 6.28 inclusive.

9.8 In connection with OWNER Engineer's responsibilities as to Change Orders, see Articles 10, 11 and 12.

9.9 In connection with OWNER Engineer's responsibilities in respect to Applications for Payment, etc., see Article 14.

Determinations for Unit Prices:

9.10 OWNER's Engineer will determine the final actual quantities and classifications of any Unit Price Work performed by CONTRACTOR. OWNER's Engineer will review with CONTRACTOR, OWNER Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). OWNER Engineer's written decisions thereon will be final and binding upon OWNER and CONTRACTOR.

Decisions on Disputes:

9.11 OWNER's Engineer will be the interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. Claims, disputes and other matters relating to the acceptability of the Work or the interpretation of the requirements of the Contract Documents pertaining to the performance and furnishing of the Work, and claims under Articles 11 and 12 in respect of changes in the Contract Price or Contract Time, will be referred initially to OWNER's Engineer in writing, with a request for a formal decision in accordance with this paragraph, which OWNER's Engineer will render in writing within a reasonable time. Written notice of each such claim, dispute and other matter will be delivered by the CONTRACTOR (but in no event later than thirty (30) calendar days) after the occurrence of the event giving rise thereto, and written supporting data will be submitted to OWNER's Engineer within sixty (60) calendar days after such occurrence, unless OWNER's Engineer allows an additional period of time to ascertain more accurate data in support of the claim.

9.12 When functioning as interpreter and judge under paragraphs 9.10 and 9.11, it is hereby mutually agreed between OWNER and CONTRACTOR that OWNER's Engineer will not be personally liable in connection with any non-negligent interpretation or decision rendered in good faith in such official and professional capacity. The rendering of a decision by OWNER's Engineer pursuant to paragraphs 9.10 and 9.11 with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment as provided in paragraph 14.16) will be a condition precedent to any exercise by CONTRACTOR and/or OWNER of such rights or remedies they may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such claim, dispute or other matter.

Limitations on OWNER Engineer's Responsibilities:

9.13 Neither OWNER Engineer's authority to act under this Article 9, or elsewhere in the Contract Documents, nor any decision made by OWNER Engineer in good faith either to exercise or not exercise such authority, shall give rise to any personal duty or personal responsibility of OWNER Engineer to CONTRACTOR, and Subcontractor, any Supplier, or any other person or organization performing any of the Work, or to any surety for any of them.

9.14 Whenever in the Contract Documents the terms: "as ordered"; "as directed"; "as required"; "as allowed"; "as approved"; or terms of like effect or import are used, or the adjectives: "reasonable"; "suitable"; "acceptable"; "proper"; or "satisfactory"; or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of OWNER's Engineer as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate the Work for compliance with the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to OWNER's Engineer any duty to supervise or direct the furnishing, performance, or quality control of the CONTRACTOR's Work or any duty or authority to undertake responsibility of the CONTRACTOR contrary to the provisions of paragraph 9.15 or 9.16.

9.15 OWNER's Engineer will not be responsible for CONTRACTOR's means, methods, techniques, quality control, sequences or procedures of construction, or the safety precautions and programs incident thereto, for which CONTRACTOR shall be solely responsible. OWNER's Engineer will not be responsible for CONTRACTOR's failure to perform or furnish the Work in

accordance with the Contract Documents.

9.16 OWNER's Engineer will not be responsible for the acts and/or omissions of CONTRACTOR or of any Subcontractor, any Supplier, or of any other person or organization performing or furnishing any of the Work.

ARTICLE 10. CHANGES IN THE WORK

10.1 Without invalidating the Agreement and without notice to any surety, OWNER may, at any time, or from time to time, order additions, deletions or revisions in the Work that are in compliance with State public competitive bidding statutes and laws governing Change Orders; these will be authorized by a Written Amendment, a Change Order, or a Work Directive Change. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved, which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

10.2 If OWNER and CONTRACTOR are unable to agree as to the extent, if any, of an increase or decrease in the Contract Price, or an extension or shortening of the Contract Time that should be allowed as a result of a Work Directive Change, a claim may be made therefore as provided in Article 11 or Article 12. All increases or decreases in the Contract Price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

10.3 CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Time with respect to any Work performed that is not required by the Contract Documents as amended, modified and supplemented as provided in paragraphs 3.4 and 3.5, except in the case of an emergency as provided in paragraph 6.22, and except in the case of uncovering Work as provided in paragraph 13.9.

10.4 OWNER and CONTRACTOR may execute appropriate Change Orders (or Written Amendments) covering:

10.4.1 changes in the Work which are ordered by OWNER pursuant to paragraph 10.1; are required because of willing acceptance of defective Work by OWNER under paragraph 13.13; or correcting defective Work under paragraph 13.14; or are otherwise agreed to by the parties;

10.4.2 changes in the Contract Price or Contract Time which are agreed to by the parties; and

10.4.3 changes in the Contract Price or Contract Time which embody the substance of any written decision rendered by OWNER's Engineer pursuant to paragraph 9.11; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, CONTRACTOR shall carry on the Work and adhere to the Progress Schedule as provided in paragraph 6.29.

10.5 If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Time) is required by the provisions of any Bond to be given to a surety by CONTRACTOR, the giving of any such notice will be CONTRACTOR'S sole responsibility, and the amount of each applicable Bond may be adjusted accordingly.

ARTICLE 11. CHANGE OF CONTRACT PRICE

11.1 The Contract price constitutes the total compensation (subject to authorized adjustments) payable to CONTRACTOR for performing the Work. All original duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at his expense without change in the original Contract price.

11.2 The Contract price may only be changed by a Change Order or by a Written Amendment. Any claim for an increase or decrease in the Contract price shall be based on initial written notice delivered promptly by the CONTRACTOR or OWNER to the other party, and to OWNER'S Engineer promptly (but in no event later than thirty (30) calendar days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall follow and be delivered within sixty (60) calendar days after such occurrence (unless OWNER's Engineer allows an additional period of time to ascertain more accurate data in support of the claim), and shall be accompanied by claimant's written statement that the amount claimed covers all known amounts (direct, indirect and consequential) to which the claimant believes he is entitled as a result of the occurrence of said event. All claims for adjustment in the Contract price shall be determined by OWNER's Engineer in accordance with paragraph 9.11. No claim for an adjustment in the Contract price will be valid if not submitted in accordance with this paragraph 11.2.

11.3 The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract price shall be determined in one of the following ways:

11.3.1 Where the Work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved (subject to the provisions of paragraphs 11.9.1. through 11.9.3. inclusive).

11.3.2 By mutual acceptance of a lump sum (which may include an allowance for overhead and profit not necessarily in accordance with paragraph 11.6.2.1).

11.3.3 On the basis of the Cost of the Work (determined as provided in paragraphs 11.4 and 11.5), plus a CONTRACTOR's Fee for overhead and profit (determined as provided in paragraphs 11.6 and 11.7).

Cost of the Work:

11.4 The term "Cost of the Work" means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. Except as otherwise may be

agreed to in writing by OWNER, such costs shall be in amounts no higher than those prevailing in the Cameron County, Texas area and shall include only the following items, and shall not include any of the costs itemized in paragraph 11.5:

11.4.1 Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under Schedules of Job Classifications as set forth by OWNER in the Supplementary General Conditions of the Contract Documents. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of any fringe benefits, if any, which shall include social security contributions, unemployment, excise and payroll taxes, workers' or workmen's compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday, as may be applicable thereto. Such employees shall include superintendents and foremen at the Project site. The expenses of performing Work after regular daily working hours on Saturday, Sunday or on legal holidays, shall be included in the above, to the extent authorized by OWNER.

11.4.2 Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR, unless OWNER deposits funds with CONTRACTOR with which to make advanced payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds and all returns from sale of surplus materials and equipment, shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.

11.4.3 Payments made by CONTRACTOR to the Subcontractors for Work performed by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to CONTRACTOR, and shall deliver such bids to OWNER who will then determine which bid will be accepted. If a subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a Fee, the Subcontractor's Cost of the Work shall be determined in the same manner as CONTRACTOR's Cost of the Work. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

11.4.4 Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys and accountants) employed for services specifically related to the Work.

11.4.5 Supplemental costs including the following:

11.4.5.1 The proportion of necessary transportation, travel and subsistence expenses of CONTRACTOR's employees incurred in discharge of duties connected with the Work.

11.4.5.2 Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the Project site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost less market value of such items used, but not consumed, which remain the

property of CONTRACTOR.

11.4.5.3 Rentals of all construction equipment and machinery and the parts thereof, whether rented from CONTRACTOR or others, in accordance with rental agreements approved by OWNER, and the costs of transportation, loading, unloading, installation, dismantling and removal thereof (all in accordance with terms of said rental agreements). The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

11.4.5.4 Any sales, consumer, use or similar taxes related to the Work that OWNER is not exempt from paying, and for which CONTRACTOR is liable, imposed by Laws and Regulations.

11.4.5.5 Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them, or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

11.4.5.6 Losses and damages (and related expenses), not compensated by insurance or otherwise, to the Work, or otherwise sustained by CONTRACTOR in connection with the performance and furnishing of the Work, provided they have resulted from causes other than the intentional and/or negligent acts and/or omissions of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them, or for whose acts and/or omissions any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's Fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, CONTRACTOR shall be paid for reconstruction services, a fee proportionate to that stated in paragraph 11.6.2.

11.4.5.7 The cost of utilities, fuel and sanitary facilities at the Project site.

11.4.5.8 Minor expenses such as telefaxes, long distance telephone calls, telephone service at the Project site, express mailings and similar petty cash items in connection with the Work.

11.4.5.9 Cost of premiums for additional Bonds and insurance required because of changes in the Work.

11.5 The term "Cost of the Work" shall not include any of the following:

11.5.1 Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the Project site or in CONTRACTOR's principal or a branch office for general administration of the Work and not specifically included in the agreed upon Schedule of Job Classifications referred to

in paragraph 11.4.1, or specifically covered by paragraph 11.4.4, all of which are to be considered administrative costs covered by the CONTRACTOR's Fee.

11.5.2 Expenses of CONTRACTOR's principal and branch offices, other than any CONTRACTOR's office at the Project site.

11.5.3 Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent CONTRACTOR payments.

11.5.4 Cost of premiums for all Bonds and for all insurance, whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for the cost of premiums covered by subparagraph 11.4.5.9 above).

11.5.5 Costs due to the intentional and/or negligent acts and/or omissions of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them, or for whose acts and/or omissions any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

11.5.6 Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in paragraph 11.4.

CONTRACTOR's Fee:

11.6 The CONTRACTOR's Fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:

11.6.1 a mutually acceptable fixed fee; or if none can be agreed upon,

11.6.2 a fee based on the following percentages of the various portions of the Cost of the Work:

11.6.2.1 for costs incurred under paragraphs 11.4.1 and 11.4.2, the CONTRACTOR's Fee shall be fifteen (15%) percent;

11.6.2.2 for costs incurred under paragraph 11.4.3, the CONTRACTOR's Fee shall be five (5%) percent; and if a subcontract is on the basis of Cost of the Work Plus a Fee, the maximum allowable to CONTRACTOR on account of overhead and profit of all Subcontractors shall be fifteen (15%) percent;

11.6.2.3 no fee shall be payable on the basis of costs itemized under paragraphs 11.4.4, 11.4.5 and 11.5;

11.6.2.4 the amount of credit to be allowed by CONTRACTOR to OWNER for any such change which results in a net decrease in cost will be the amount of the actual net decrease, plus a deduction in CONTRACTOR's Fee by an amount equal to ten (10%)

percent of the net decrease; and

11.6.2.5 when both additions and credits are involved in any one change, the adjustment in CONTRACTOR'S Fee shall be computed on the basis of the net change in accordance with paragraphs 11.6.2.1 through 11.6.2.4, inclusive.

11.7 Whenever the cost of any Work is to be determined pursuant to paragraph 11.4 or 11.5, CONTRACTOR will submit in a form acceptable to OWNER's ENGINEER, an itemized cost breakdown together with supporting data.

Cash Allowances:

11.8 It is understood that CONTRACTOR has included in the Contract price all allowances so named in the Contract Documents and shall cause the Work so covered to be done by such Subcontractors or Suppliers, and for such sums within the limit of the allowances as may be acceptable to OWNER. CONTRACTOR agrees that:

11.8.1 The allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Project site, and all applicable non-exempt taxes; and

11.8.2 CONTRACTOR's costs for unloading and handling on the Project site, labor, installation costs, overhead, profit and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances. No demand for additional payment on account of any thereof will be valid.

Prior to final payment, an appropriate Change Order will be issued as recommended by OWNER's Engineer to reflect actual amounts due CONTRACTOR on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

Unit Price Work:

11.9

11.9.1 Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit prices for each separately identified item of Unit Price Work, times the estimated quantity of each item as indicated in the Agreement. The OWNER's estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual final quantities and classifications of Unit Price Work performed by CONTRACTOR will be made by OWNER's Engineer in accordance with Paragraph 9.10.

11.9.2 Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

11.9.3 Where the quantity of any item of Unit Price Work performed by CONTRACTOR differs materially and significantly from the OWNER's estimated quantity of such item indicated in the Agreement (generally plus or minus 25%), and there is no corresponding and offsetting adjustment(s) with respect to any other item(s) of Work, and if CONTRACTOR believes that CONTRACTOR has incurred additional expense as a result thereof, CONTRACTOR may make a claim for an increase in the Contract Price in accordance with Article 11 and any applicable State law, if the parties are unable to otherwise agree as to the amount of any such increase.

ARTICLE 12 -- CHANGE OF CONTRACT TIME

12.1 The Contract Time may only be changed by a Change Order or a Written Amendment. Any claim for an extension or shortening of the Contract Time shall be based on initial written notice delivered by the CONTRACTOR or OWNER to the other party (but in no event later than thirty (30) calendar days) after the occurrence of the event giving rise to the claim, and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall follow and be delivered within sixty (60) calendar days after such occurrence (unless OWNER's Engineer allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant has reason to believe it is entitled as a result of the occurrence of said event. All claims for adjustment in the Contract Time shall be determined by OWNER's Engineer in accordance with paragraph 9.11. No claim for an adjustment in the Contract Time will be valid if not submitted in accordance with the requirements of this paragraph 12.1.

12.2 The Contract Time will be extended in an amount equal to time lost due to delays beyond the reasonable control of CONTRACTOR, so long as CONTRACTOR has made good faith efforts to mitigate delaying impacts and if a claim is made therefore as provided in paragraph 12.1. Such delays shall include, but not be limited to, acts or neglect by OWNER or others performing additional separate work as contemplated by Article 7, or to fires, floods exceeding the 100 year frequency, labor disputes, epidemics, extremely abnormal weather for Cameron County, Texas, as may be described further in these Contract Documents, or Acts of God.

12.3 **ALL TIME LIMITS STATED IN THE CONTRACT DOCUMENTS ARE MUTUALLY AGREED TO BE OF THE ESSENCE OF THE AGREEMENT.** The provisions of this Article 12 shall not exclude recovery for damages (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court costs) for delay by either party.

ARTICLE 13 -- WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

Warranty and Guarantee:

13.1 CONTRACTOR warrants and guarantees to OWNER that all Work will be in accordance with the Contract Documents and will not be defective. Prompt notice of any obvious

patent defects discovered by OWNER shall be given to CONTRACTOR. All defective Work, whether or not in place, may be rejected, corrected or accepted as provided in this Article 13. In case of dispute as to the cause of improper functioning of all or any part of the Work, the burden of proof that CONTRACTOR has complied with the Contract Documents rests with CONTRACTOR for this Work. He shall submit in writing to OWNER's Engineer his opinion and basis of proof for the adequacy of his Work. OWNER may have those tests made, which OWNER deems advisable, by an independent testing laboratory of OWNER's choice. If any test so made indicates a defect in material or workmanship, or that one or more manufactured components of the Work are performing below the standard set by the manufacturer's public data and specifications, the entire cost of all such tests shall be paid for by CONTRACTOR, and he shall also pay for retesting of the corrected Work, until it functions satisfactorily. The Work shall be guaranteed to be free from defects due to faulty workmanship or material for a period of one (1) year from the date of OWNER issue of the Certificate of Acceptance. Work found to be improper or imperfect shall be replaced or redone without cost to OWNER within the one year guarantee period. Neither the Certificate of Acceptance, final payment, or any other provision of the Contract Documents shall free CONTRACTOR from his workmanship guarantee. Failure to repair or replace faulty Work entitles OWNER to repair or replace the same and recover the costs from CONTRACTOR and/or his Surety. CONTRACTOR shall be the sole guarantor of the Work installed under this Contract and no third party guarantees/warranties by Subcontractors or suppliers of various components or materials will be acceptable; nor shall agreements with Subcontractors or material or component suppliers by CONTRACTOR reduce CONTRACTOR's responsibility to OWNER under this Agreement. All equipment shall be warrantied and/or guaranteed be either CONTRACTOR or its supplier/manufacturer to OWNER for at least one (1) year from the date of OWNER acceptance of the entire Project. It is anticipated by OWNER and acknowledged by CONTRACTOR that many equipment and material warranties from manufacturers shall extend well beyond the initial one (1) year post acceptance period. The CONTRACTOR shall transfer to the OWNER any and all third party supplier and manufacturer warranties and/or guaranties that remain in effect beyond the one (1) year workmanship guarantee/warranty period.

Access to Work:

13.2. OWNER, OWNER's Engineer, OWNER's Field Representative, other representatives of OWNER, testing agencies and governmental agencies with jurisdictional interests, will have access to the Work at reasonable times for their observation, inspecting and testing. CONTRACTOR shall provide proper and safe conditions for such reasonable access.

It is agreed by CONTRACTOR that OWNER shall be and is hereby authorized to appoint from time to time, OWNER Engineer's subordinate supervisors, observers, and/or inspectors, as the said OWNER may deem proper to inspect the material furnished and observe the Work performed under this construction Agreement, and to see that the said material is furnished and said Work is generally done in accordance with the Specifications. This OWNER function, for OWNER's sole benefit, does not excuse the CONTRACTOR from quality control assurance, which is solely his responsibility. CONTRACTOR shall furnish all reasonable aid and assistance required by the OWNER's Engineer, subordinate supervisors, observers and/or inspectors for the proper observation, inspection and examination of the Work and all parts of the Work. CONTRACTOR shall regard and obey the directions and instructions of the OWNER's

Engineer and any subordinate supervisors, or inspector so appointed, when such directions are consistent with the obligations of this Agreement and the accompanying Specifications, provided, however, that should CONTRACTOR object to any order by any subordinate supervisor or inspector, CONTRACTOR may within six (6) calendar days make written notice to OWNER for his decision. Except as herein before provided, the authority of subordinate supervisors or inspectors shall be limited to the rejection of unsatisfactory Work and materials and to the suspension of the Work, until the questions of Work acceptability can be referred to OWNER's Engineer.

13.2.1. CONTRACTOR shall cooperate with any OWNER testing laboratory to the end that the function and services of the laboratory may be properly performed. CONTRACTOR shall give OWNER's representative and testing laboratory a minimum of twenty-four (24) hours notice of readiness for all testing as required by the Specifications or customary construction industry standards. OWNER shall bear the cost of density and concrete testing, for first test only. Testing of equipment, lines and valves shall be the responsibility of CONTRACTOR and he shall notify OWNER's Engineer and/or inspectors of his scheduled time for such tests, so that the test can be witnessed by an OWNER's representative. If initial tests show failure, the CONTRACTOR shall cover the costs of retesting the areas that failed after corrective action has been taken, as well as the personnel and equipment costs incurred by OWNER in said retesting, on a per diem basis. The per diem costs shall be determined based on the hourly wage plus reasonable overhead of OWNER's personnel needed and present at the Project site during retesting, and by the locally prevailing rental rate for the vehicles and equipment utilized in retesting. These retesting time costs shall be paid by CONTRACTOR prior to OWNER's acceptance of the Work improvements.

Tests and Inspections:

13.3. CONTRACTOR shall give OWNER's Engineer and /or OWNER's Field Representative timely notice of readiness of the Work for all required inspections, tests or approvals.

13.4. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) to specifically be inspected, tested or approved, CONTRACTOR shall assume full responsibility therefore, pay all costs in connection therewith, and furnish OWNER's Engineer the required final certificates of inspection, testing or approval. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any special inspection or testing required in connection with OWNER Engineer's approval and acceptance of an alternative Supplier of "or equal" proposed substitutions of materials or equipment proposed by CONTRACTOR to be incorporated in the Work, or of materials or equipment submitted for approval prior to CONTRACTOR's purchase thereof, for incorporation in the Work. The cost of all routine inspections, tests and approvals, other than any of those special inspections which may be required by the Contract Documents to be paid by CONTRACTOR, shall be paid by OWNER (unless otherwise specified).

13.5 All inspections, tests or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to OWNER (or by OWNER's Engineer, if so specified).

13.6 If any Work (including the work of others) that is to be inspected, tested or approved is covered or otherwise concealed by CONTRACTOR without written concurrence of OWNER's Engineer, it must, if requested by OWNER'S Engineer, be uncovered and revealed for OWNER observation. Such uncovering shall be at CONTRACTOR's expense, unless CONTRACTOR has given OWNER's Engineer timely notice of CONTRACTOR's intention to cover the same and OWNER's Engineer has not acted with reasonable promptness in response to such CONTRACTOR notice.

13.7 Neither observations by OWNER's Engineer nor inspections, tests or approvals by others shall relieve CONTRACTOR from CONTRACTOR's obligations to perform the Work and constantly employ quality control in accordance with the Contract Documents.

Uncovering Work:

13.8 If any Work is covered contrary to the written request of OWNER's Engineer, it must, if requested by OWNER's Engineer, be uncovered for OWNER Engineer's observation and replaced at CONTRACTOR's expense.

13.9 If OWNER's Engineer considers it necessary or advisable that covered Work be observed by OWNER's Engineer or inspected or tested by others, CONTRACTOR, at OWNER Engineer's request, shall uncover, expose or otherwise make available for observation, inspection or testing as OWNER'S Engineer may require, that portion of the Work in question, furnishing all necessary labor, material and equipment to uncover same. If it is found that such Work is defective, CONTRACTOR shall bear all direct, indirect and consequential costs of such uncovering, exposure, observation, inspection and testing, and of satisfactory repair, replacement and reconstruction, (including but not limited to fees and charges or engineers, architects, attorneys and other professionals), and OWNER shall be entitled to an appropriate decrease in the Contract Price, and if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefore as provided in Article 11. If, however, such Work is not found to be defective, CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, repair, replacement and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a claim therefore as provided in Articles 11 and 12. All increases or decreases in the Contract price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Owner May Stop the Work:

13.10 If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such stop Work order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to exercise this right for the benefit of CONTRACTOR, or any other party.

Correction or Removal of Defective Work:

13.11 If required by OWNER's Engineer, CONTRACTOR shall promptly, as directed, either correct all defective Work, whether or not fabricated, installed or completed, if the Work has been rejected by OWNER's Engineer, and remove it from the Project site and replace it with non-defective Work. CONTRACTOR shall bear all direct, indirect and consequential costs of such correction or removal (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) made necessary thereby.

One Year Workmanship Correction Period:

13.12 If within one (1) year after the date of OWNER issuance of the Certificate of Acceptance, or such longer period of time as may be prescribed by Laws or Regulations, or by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents, any Work is found to be defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions, either correct such defective Work, or, if it has been rejected by OWNER, remove it from the Project site and replace it with non-defective Work. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the defective Work corrected, or the rejected Work removed and replaced, and all direct, indirect and consequential costs of such removal and replacement (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) will be paid by CONTRACTOR. In special circumstances, where a particular item of equipment is placed in continuous service before acceptance of all the Work, the minimum one (1) year workmanship guarantee and equipment warranty correction period for that item may start to run from an earlier date, if so provided in the Specifications or by Written Amendment.

Acceptance of Defective Work:

13.13 If instead of requiring correction or removal and replacement of defective Work, OWNER (and, prior to OWNER Engineer's recommendation of final payment), prefers to accept it as is, OWNER may do so. CONTRACTOR shall bear all direct, indirect and consequential costs attributable to OWNER's evaluation of, and determination to accept such defective Work (such costs to be approved by OWNER's Engineer as to reasonableness and to include but not be limited to fees and charges of engineers, architects, attorneys and other professionals). If any such OWNER acceptance occurs prior to OWNER Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions to the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefore as provided in Article 11. If the acceptance occurs after such final payment, an appropriate amount as determined by OWNER will be paid by CONTRACTOR to OWNER.

OWNER May Correct Defective Work:

13.14 If CONTRACTOR fails within a reasonable time after written notice by OWNER's Engineer to proceed to correct, and to actually correct defective Work; or to remove and replace rejected Work as required by OWNER's Engineer in accordance with paragraph 13.11; or if

CONTRACTOR fails to perform the Work in accordance with the Contract Documents; or if CONTRACTOR fails to comply with any other provision of the Contract Documents; OWNER may, after seven (7) calendar days written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph, OWNER shall proceed with reasonable expediency. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the Project site; take possession of all or part of the Work; and suspend CONTRACTOR's services related thereto; take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the Project site; and incorporate in the Work all materials, and CONTRACTOR shall allow OWNER, OWNER's representatives, and employees such access to the Project site as may be necessary to enable OWNER to exercise the rights and remedies under this paragraph. All direct, indirect and consequential costs of OWNER in exercising such rights and remedies will be charged against CONTRACTOR, in an amount approved as to reasonableness by ENGINEER, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefore as provided in Article 11. Such direct, indirect and consequential costs will include, but not be limited to: fees and charges of engineers; architects; attorneys; and other professionals; all court costs; and all costs of repair and replacement of work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR's defective Work. CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies hereunder.

ARTICLE 14 -- PAYMENTS TO CONTRACTOR AND COMPLETION

Schedule of Values:

14.1 The Schedule of Values established as provided in paragraph 2.9 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to OWNER's Engineer. Progress payments on account of Unit Price Work will be based on the number of units actually completed.

Application for Progress Payment:

14.2 At least twenty (20) calendar days before each progress payment is scheduled (but not more often than once a month), CONTRACTOR shall submit to OWNER for review, an Application for Payment filled out and signed by CONTRACTOR, covering the Work completed as of the date of the Application, and accompanied by such supporting documentation as is required by the Contract Documents. The amount of retainage with respect to progress payments (customarily 5%) will be as stipulated in the Agreement.

CONTRACTOR's Warranty of Title:

14.3 CONTRACTOR warrants and guarantees that title to any Work and materials covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER no later than the time of payment, free and clear of any and all prior claims for payment.

Review of Applications for Progress Payment:

14.4 OWNER's Engineer will, within ten (10) calendar days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and process the Application, or return the Application to CONTRACTOR indicating in writing OWNER's reasons for refusing to recommend payment. In the latter case, CONTRACTOR may make the necessary corrections and resubmit the Application. Twenty (20) calendar days after presentation of the Application for Payment with OWNER Engineer's recommendation, the amount recommended will (subject to the provisions of the last sentence of paragraph 14.7) become due, and when due will be paid by OWNER to CONTRACTOR.

14.5 OWNER Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by OWNER's Engineer, based upon ENGINEER's limited on-site observations of the Work in progress as an experienced and qualified design professional; and on OWNER Engineer's review of the Application for Payment and the accompanying data and Schedules; that the Work has progressed to the point indicated, that, to the best of OWNER Engineer's knowledge, information and belief, the status of the Work is in apparent general accord with the Contract Documents (subject to: a later evaluation of the Work as a functioning whole; prior to or upon Substantial Completion; and subject to the results of any subsequent tests called for in the Contract Documents; and subject to a final determination of quantities and classifications for Unit Price Work under paragraph 9.10; and subject to any other qualifications stated in the OWNER Engineer's recommendation); and that CONTRACTOR is entitled to payment of the amount recommended. However, by recommending any such payment, OWNER's Engineer will not thereby be deemed to have represented that exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work beyond the responsibilities specifically assigned to OWNER's Engineer in the Contract Documents, or that there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER, or OWNER to withhold payment to CONTRACTOR.

14.6 OWNER Engineer's recommendation of final payment will constitute an additional representation by OWNER that to the best of OWNER Engineer's knowledge, the conditions precedent to CONTRACTOR's being entitled to final payment, as set forth in paragraph 14.13, have been fulfilled.

14.7 OWNER's Engineer may refuse to recommend the whole or any part of any payment if, in OWNER Engineer's professional opinion, it would be incorrect to make such representations to OWNER. OWNER Engineer may also refuse to recommend any such payment, or, because of subsequently discovered evidence, or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in OWNER Engineer's opinion, to protect OWNER from loss because:

14.7.1 the Work is defective, or completed Work has been damaged requiring correction or replacement.

14.7.2 the Contract Price has been reduced by Written Amendment or Change Order.

14.7.3 OWNER has been required to correct defective Work or complete Work in accordance with paragraph 13.14, or

14.7.4 because of OWNER Engineer's actual knowledge of the occurrence of any of the events enumerated in paragraphs 15.2.1 through 15.2.9 inclusive.

OWNER may for its own benefit and protection and not for the direct benefit of any third parties, refuse to make payment in whole or in part of the amount recommended by OWNER's Engineer, because claims have been made against OWNER on account of CONTRACTOR's improper performance of the Work, or payment bond claims have been filed in connection with the Work and OWNER wishes to consult with CONTRACTOR and/or CONTRACTOR's surety, or there are other items entitling OWNER to a set-off against the amount recommended, but OWNER must give CONTRACTOR written notice stating the reasons for such action.

Substantial Completion:

14.8 When CONTRACTOR considers the entire Work ready for OWNER's intended use, CONTRACTOR shall notify OWNER's Engineer in writing that the entire Work is Substantially Complete (except for items specifically listed by CONTRACTOR as incomplete) and request that OWNER issue a certificate of Substantial Completion. Within a reasonable time thereafter, OWNER and CONTRACTOR shall make an inspection of the Work to determine the status of completion. If OWNER's Engineer does not consider the Work Substantially Complete, OWNER's Engineer will notify CONTRACTOR in writing giving the reasons therefore. If OWNER's Engineer considers the Work Substantially Complete, OWNER's Engineer will prepare and process a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of pending items to be completed or corrected before final payment ("punch-list"). At the time of delivery of the tentative certificate of Substantial Completion, OWNER's Engineer will deliver to CONTRACTOR a written recommendation as to the division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities, insurance and warranties. OWNER Engineer's aforesaid recommendation will be binding on OWNER and CONTRACTOR, until final payment.

14.9 OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the punch list.

Partial Utilization:

14.10 Use by OWNER of any finished part of the Work, which has specifically been identified in the Contract Documents, or which OWNER and CONTRACTOR agree constitutes a separately functioning and useable part of the Work that can be used by OWNER without significant interference with CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work, subject to the following:

14.10.1 OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any such part of the Work which OWNER believes to be ready for

OWNER's intended use and Substantially Complete. If CONTRACTOR agrees, CONTRACTOR will certify to OWNER that said part of the Work is Substantially Complete and request OWNER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time after such request, OWNER, and CONTRACTOR shall make an inspection of that part of the Work to determine its status of completion. If OWNER considers that part of the Work to be Substantially Complete, the provisions of paragraphs 14.8 and 14.9 will apply with respect to certification of Substantial Completion of that part of the Work, and the division of responsibility in respect thereof and access thereto.

14.10.2 OWNER may at any time request CONTRACTOR in writing to permit OWNER to take over operation of any such part of the Work, although it is not Substantially Complete. A copy of such request will be sent to OWNER's Engineer and within a reasonable time thereafter OWNER, and CONTRACTOR, shall make an inspection of that part of the Work to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If CONTRACTOR does not object in writing to OWNER that such part of the Work is not ready for separate operation by OWNER, OWNER's Engineer will finalize the list of items to be completed or corrected and will deliver such list to CONTRACTOR, together with a written statement as to the division of responsibilities pending final payment between OWNER and CONTRACTOR, with respect to security, operation, safety, maintenance, HVAC, utilities, insurance, warranties and guarantees for that part of the Work, which will become binding upon OWNER and CONTRACTOR at the time when OWNER takes over such operation. During such operation and prior to Substantial Completion of such part of the Work, OWNER shall allow CONTRACTOR reasonable access to complete or correct items on any punch list, and to complete other related Work.

14.10.3 No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of paragraph 5.15 in respect of CONTRACTOR's property insurance.

Final Inspection:

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

A qualified person representing CONTRACTOR shall be present at this final inspection. Prior to this inspection, all Work shall have been completed, tested, adjusted and in final operating condition, if required by the Project Specifications.

Final Application for Payment:

14.12 After CONTRACTOR has completed all such corrections to the satisfaction of OWNER's Engineer and delivered certificates of inspection, marked-up record documents, if any, depicting as-built conditions (as provided in paragraph 6.19) and other documents--all as required by the Contract Documents; and after OWNER's Engineer has indicated that the Work is

acceptable (subject to the provisions of paragraph 14.16), CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to OWNER) of all claims arising out of, or filed in connection with the Work. In lieu thereof and as approved by OWNER, CONTRACTOR may furnish receipts or releases in full; an affidavit of CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a Payment Bond claim could be filed, and that all payrolls, material and equipment bills, and other indebtedness connected with the Work, for which OWNER or OWNER's property might in any way be encumbered, have been paid or otherwise satisfied; and consent of the surety to final payment, if any is required by surety. If any Subcontractor or Supplier fails to furnish a release or receipt in full, CONTRACTOR may furnish a special indemnity Bond, or other collateral satisfactory to OWNER, to indemnify OWNER against any potential third party claim.

Final Payment and Acceptance:

14.13 If, on the basis of OWNER Engineer's observation of the Work during construction and final inspection, and OWNER Engineer's review of the final Application for Payment, and accompanying documentation (all as required by the Contract Documents), OWNER's Engineer is satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, OWNER's Engineer will, within twenty (20) calendar days after receipt of the final Application for Payment, indicate in writing, OWNER Engineer's recommendation of payment and process the Application for Payment. Thereupon OWNER's Engineer will give written notice to CONTRACTOR that the Work is acceptable, subject to the provisions of paragraph 14.16. Otherwise, OWNER's Engineer will return the Application to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application. Thirty (30) calendar days after presentation to OWNER of the Application for Payment and accompanying documentation, in appropriate final form and substance, and with OWNER Engineer's recommendation and notice of acceptability, the amount recommended by OWNER's Engineer will become due and will be paid by OWNER to CONTRACTOR.

CONTRACTOR shall submit satisfactory evidence to the OWNER that all payrolls, and other indebtedness connected with the Work have been paid, before a Final Certificate of Acceptance is issued.

14.14 If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed, OWNER shall, upon receipt of CONTRACTOR's final Application for Payment and recommendation of OWNER's Engineer, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.1, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to OWNER's Engineer with the Application for such Payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a final waiver of claims by OWNER.

Contractor's Continuing Obligation:

14.15 CONTRACTOR'S obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. Neither recommendation of any progress or final payment by OWNER's Engineer; nor the issuance of a Certificate of Substantial Completion or Final Acceptance; nor any payment by OWNER to CONTRACTOR under the Contract Documents; nor any use or occupancy of the Work or any part thereof by OWNER; nor any act of acceptance by OWNER; nor any failure to do so; nor the issuance of a notice of acceptability by OWNER's Engineer pursuant to paragraph 14.13; nor any correction of defective Work by OWNER, will constitute an acceptance of Work not in accordance with the Contract Documents, or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents (except as provided in paragraph 14.16).

Waiver of Claims:

14.16 The making and acceptance of final payment will constitute:

14.16.1 a waiver of all claims by OWNER against CONTRACTOR, except third party claims arising from unsettled payment bond claims; from latently defective Work appearing after final inspection pursuant to paragraph 14.11; or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; however, it will not constitute a waiver by OWNER of any rights regarding CONTRACTOR's continuing obligations under the Contract Documents; and

14.16.2 a waiver of all claims by CONTRACTOR against OWNER, other than those previously and properly made in writing and still unsettled.

ARTICLE 15 -- SUSPENSION OF WORK AND TERMINATION

Owner May Suspend Work:

15.1 OWNER may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than thirty (30) calendar days by notice in writing to CONTRACTOR, which will fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension, if CONTRACTOR demonstrates an approved claim therefore as provided in Articles 11 and 12. Any increase or decrease in the Contract Price shall be governed by all State and local laws, statutes, codes, ordinances, rules and regulations governing public competitive bidding and Change Orders.

Owner May Terminate:

15.2 Upon the occurrence of any one or more of the following events:

15.2.1 if CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if

CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise, under any other federal or State law in effect at such time, relating to the bankruptcy or insolvency;

15.2.2 if a petition is filed against CONTRACTOR under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against CONTRACTOR under any other federal or State law in effect at the time relating to bankruptcy or insolvency;

15.2.3 if CONTRACTOR makes a general assignment for the benefit of creditors;

15.2.4 if a trustee, receiver, custodian or agent of CONTRACTOR is appointed under applicable law or under contract, whose appointment or authority to take charge of the property of CONTRACTOR is for the purpose of enforcing a lien against such CONTRACTOR property, or for the purpose of general administration of such CONTRACTOR property, for the benefit of CONTRACTOR's creditors;

15.2.5 if CONTRACTOR admits in writing an inability to pay its debts generally as they become due;

15.2.6 if CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including but not limited to, failure to supply sufficient skilled workers or equipment, or failure to adhere to the Progress Schedule established under paragraph 2.9, as revised from time to time);

15.2.7 if CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;

15.2.8 if CONTRACTOR disregards the rights of OWNER; or

15.2.9 if CONTRACTOR otherwise violates in any substantial and material way, any provisions of the Contract Documents;

OWNER may, after giving CONTRACTOR and the surety seven (7) calendar days written notice, and to the extent permitted by Laws and Regulations: terminate the services of CONTRACTOR; exclude CONTRACTOR from the site and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment and machinery at the Project site; and use the same to the full extent they could be used by CONTRACTOR (without OWNER liability to CONTRACTOR for trespass or conversion), and finish the Work as OWNER may deem expedient. In such case, CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract price exceeds the OWNER's direct, indirect and consequential costs of completing the Work (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court costs), such excess will be paid to CONTRACTOR or surety. If such OWNER costs exceed such unpaid balance, CONTRACTOR or surety shall pay the difference to OWNER. Such costs incurred by OWNER will be incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, OWNER shall not be required to obtain the lowest price for the Work performed.

15.3 Where CONTRACTOR's services have been so terminated by OWNER, the termination will not affect any rights or remedies of OWNER against CONTRACTOR then existing, or which may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by OWNER will not release CONTRACTOR from ongoing liability.

15.4 Upon seven (7) calendar days written notice to CONTRACTOR, OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the Work and terminate the Agreement. In such case, CONTRACTOR shall mitigate demobilization costs as best as possible and be paid for all Work executed and expenses sustained, plus reasonable termination expenses, which will include, but not be limited to, direct, indirect and consequential costs (including, but not limited to, fees and charges of engineers, architects, attorneys and other professionals and court costs).

15.5 (RESERVED)

ARTICLE 16 -- TIME FOR SUBSTANTIAL COMPLETION AND LIQUIDATED DAMAGES.

16.1. IT IS HEREBY UNDERSTOOD AND MUTUALLY AGREED, BY AND BETWEEN THE PARTIES HERETO, THAT THE DATE OF BEGINNING, RATE OF PROGRESS AND THE TIME FOR SUBSTANTIAL COMPLETION OF THE WORK TO BE DONE HEREUNDER ARE ESSENTIAL CONDITIONS OF THIS CONTRACT; and it is further mutually understood and agreed, by and between the parties hereto, that the time to perform the Work embraced in this Contract shall be commenced on a date to be specified in the Notice to Proceed.

16.2 CONTRACTOR agrees that said Work shall be prosecuted regularly, diligently, and uninterrupted at such rate of progress as will insure Substantial Completion thereof within the time specified. It is expressly understood and mutually agreed, by and between the parties hereto, that the time for the Substantial Completion of the Work described herein is a reasonable time for Substantial Completion of same, taking into consideration the average climatic range and weather conditions that the CONTRACTOR must reasonably anticipate, and usual industrial conditions prevailing in the Cameron County area.

16.3 If CONTRACTOR shall neglect, fail or refuse to Substantially Complete the Work within the time herein specified, then CONTRACTOR does hereby agree, as a part consideration for awarding of this Contract, to pay the OWNER the mutually agreed to amount specified in the Contract, not as a penalty, but as liquidated damages for such breach of Contract as hereinafter set forth, for each and every calendar day that CONTRACTOR shall be in default, after the time stipulated in the Contract for Substantially Completing the Work.

16.4 The damage to OWNER by reason of this Contract not being Substantially Completed as of that date are incapable of definite ascertainment by either party, and therefore the parties hereto have mutually fixed and limited such damages to the sum of Three Hundred Dollars (\$300.00) per calendar day for each calendar day the job runs beyond such Substantial Completion date, and the joint fixing of such damages constitutes a part of the consideration for the Contract. It is further agreed that **TIME IS OF THE ESSENCE** of each and every portion of this Contract

and of the Specifications, wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the Contract, additional time is allowed for the Substantial Completion of any Work, the new time fixed by such extension shall be **OF THE ESSENCE** of this Contract. Provided that CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in the Substantial Completion of Work is due:

16.4.1 To any preference, priority or allocation order duly issued by the Federal Government.

16.4.2 To unforeseeable causes beyond the control and without the fault or negligence of CONTRACTOR, including, but not restricted to: Acts of God; or of the public enemy; acts of the OWNER; acts of another contractor in the performance of a separate contract with the OWNER; fires; floods exceeding the 100 year frequency; epidemics; quarantine restrictions; strikes; freight embargoes and unusually severe weather not customary for the Cameron County, Texas area.

16.4.3 To any delays of Subcontractors occasioned by any of the causes specified in 16.4.1 or 16.4.2.

16.4.4 Provided further, that CONTRACTOR shall immediately attempt to mitigate the impacts of the delay, and then within seven (7) calendar days from the beginning of such delay, notify OWNER, in writing, of the causes of the delay. OWNER shall then ascertain the facts and extent of the delay and notify CONTRACTOR within a reasonable time of OWNER's decision in the matter regarding any adjustment to the Contract time and a recovery plan.

ARTICLE 17 -- MISCELLANEOUS

Giving Notice:

17.1 Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the CONTRACTOR's Project Superintendent or mailed to an officer of the corporation in the case of the CONTRACTOR; or to the General Manager and CEO of the BPUB in the case of the OWNER; or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

Computation of Calendar Day Time:

17.2 When any period of time is referred to in the Contract Documents by "days", and the OWNER'S format for scheduling the Project is by utilizing calendar days in lieu of working days, it will be computed as calendar days, to exclude the first and include the last calendar day of such period. If the last calendar day of any such period falls on a calendar day listed as a BPUB holiday by the Contract Documents, such calendar day will be omitted from the computation.

17.2.1 A calendar day of twenty-four hours is measured from midnight, to the next midnight, and shall constitute a single calendar day.

General:

17.3 Should OWNER suffer injury or damage to person or property because of any error, omission or negligent act of the CONTRACTOR, or of any of the CONTRACTOR's employees or agents, or others for whose acts and/or omissions CONTRACTOR is legally liable, OWNER's claim will be made in writing to the CONTRACTOR within a reasonable time of the first observance of such injury or damage. The provisions of this paragraph 17.3 shall not be construed as a substitute for, or a waiver of, the legal provisions of any applicable statute of limitations or repose.

17.4 The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the conditions, warranties, guarantees and obligations imposed upon CONTRACTOR by paragraphs 6.30, 13.1, 13.12, 13.14, 14.3 and 15.2, and all of the rights and remedies available to OWNER and OWNER'S Engineer thereunder; are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to OWNER which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this paragraph will be as effective as if repeated specifically in all the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply. All representations, conditions, warranties and guarantees made in the Contract Documents will survive the execution, final payment and termination or completion of the Agreement. All CONTRACTOR recitations contained in any document required by OWNER, whether delivered at the time of the execution of the Contract Documents, or at a later date, shall constitute representations, warranties and guarantees by CONTRACTOR herein.

17.5 CONTRACTOR shall comply with the "anti-kickback" provisions of the Copeland Act now codified at 18 U. S. C. A. §874, and all amendments or modifications of the original act of June 13, 1934.

SUPPLEMENTARY GENERAL CONDITIONS

SECTION 1 - WAGE AND LABOR STANDARD PROVISIONS-100% NON-FEDERALLY FUNDED CONSTRUCTION

Contents

1. GENERAL STATEMENT
2. BROWNSVILLE PUBLIC UTILITIES BOARD (BPUB) RESPONSIBILITIES
3. CLAIMS & DISPUTES PERTAINING TO WAGE RATES
4. BREACH OF WAGE & LABOR STANDARDS PROVISIONS
5. EMPLOYMENT OF LABORERS/MECHANICS NOT LISTED IN WAGE DETERMINATION DECISION
6. MINIMUM WAGE
7. OVERTIME COMPENSATION ON NON-FEDERALLY FUNDED PROJECTS
8. PAYMENT OF CASH EQUIVALENT FRINGE BENEFITS
9. WORK CONDUCTED ON HOLIDAYS-NON-FEDERALLY FUNDED PROJECTS
10. UNDERPAYMENT OF WAGES OR SALARIES
11. POSTING WAGE DETERMINATION DECISION/STATEMENT AND "NOTICE TO EMPLOYEES"
12. PAYROLLS & BASIC PAYROLL RECORDS
13. LABOR DISPUTES
14. COMPLAINTS, PROCEEDINGS, OR TESTIMONY BY EMPLOYEES
15. EMPLOYEE INTERVIEWS TO ASSURE WAGE & LABOR STANDARD COMPLIANCE
16. "ANTI-KICKBACK" PROVISION
17. "FALSE INFORMATION" PROVISION
18. EMPLOYMENT OF APPRENTICES/TRAINEEES
19. JOBSITE CONDITIONS
20. EMPLOYMENT OF CERTAIN PERSONS PROHIBITED
21. PROVISIONS TO BE INCLUDED IN SUBCONTRACTS

1. GENERAL STATEMENT

This is a 100% Non-Federally funded and competitively bid Public Works Contract and Texas Government Code Section 2258.001 et seq., as amended, requires that not less than the general prevailing wage rates (minimum hourly base pay and minimum hourly fringe benefit contribution) for Work of similar character be paid to CONTRACTOR and subcontractor employees. These local prevailing and adopted wage rates are derived from the most current applicable pre-Bid federal prevailing wage rates for Cameron County, Texas, as published by the United States Department of Labor, Dallas, Texas pursuant to the original intent and authority of the Resolution passed by the Public Utilities Board of Brownsville on February 24, 1992 (hereinafter referred to as "BPUB"). Copies of the wage rates are contained immediately behind these Supplementary General Conditions, and are included instruments of this Contract and full compliance with same shall be required.

Additionally, on April 16, 2007, the BPUB Board of Directors approved a local "living wage" policy that requires all Contractors and Subcontractors performing 100% Non-Federally funded Work for the BPUB to pay a minimum wage rate of \$8.00/hour, regardless of any lower federal wage rate for Cameron County. The BPUB requires that all Contractors and Subcontractors also comply with this policy. Otherwise, the BPUB adopts the Federal Department of Labor Wage scales for Cameron County on 100% Non-Federally funded projects as specified later herein behind these Supplementary General Conditions.

Any deviation from Wage and Labor Standard Provisions compliance may be cause for OWNER's withholding either interim or final payment to the CONTRACTOR until such deviations are properly corrected.

2. WAGE & HOUR OFFICE, PUBLIC WORKS, RESPONSIBILITIES

The OWNER's Engineer or the BPUB Wage & Hour Monitor is primarily responsible for all Wage and Labor Standard Provisions investigation and enforcement and will monitor Contractor/subcontractor practices to assure the BPUB General Manager and CEO that:

- a. Appropriate weekly compliance statements and payroll records are submitted to the BPUB by the Contractor/subcontractors and that such are reviewed for compliance with Wage and Labor Standard Provisions.
- b. Any Apprentices/trainees designated by CONTRACTOR as working on the Project are properly identified by Contractor/subcontractor on payroll records and documented as being included in programs currently sanctioned by appropriate federal or state regulatory agencies.
- c. Applicable Wage Determination Decisions, including any applicable modifications and related statements are posted at the Work-site by the Contractor and that proper job classifications and commensurate minimum hourly base and any fringe wage rates are paid.

- d. Employees are periodically interviewed (at random) on the Project as required.
- e. That no person employed by Contractor/subcontractor is induced against his will, by any means, to give up any part of the compensation to which he is otherwise entitled.
- f. That any and all periodic administrative directives to the OWNER'S Engineer and/or Wage & Hour Monitor from the Board and General Manager and CEO are being implemented.

3. CLAIMS & DISPUTES PERTAINING TO WAGE RATES

Claims and disputes not promptly and routinely settled by the CONTRACTOR/subcontractor and employees pertaining to wage rates, or to job classifications of labor employed upon the Work covered by this Contract, shall be reported by the employee in writing, within sixty (60) calendar days of employee's receipt of any allegedly incorrect classification, wage or benefit report, to the OWNER's Engineer and/or Wage & Hour Monitor, BPUB for further investigation. Claims and disputes not reported by the employee to the OWNER in writing within the sixty (60) calendar day period shall be deemed waived by the employee for the purposes of the OWNER administering and enforcing the OWNER's Contract rights against the CONTRACTOR on behalf of the employee. Waiver by the employee of this OWNER intervention shall not constitute waiver by the OWNER or employee to independently pursue contractual rights it may have against the CONTRACTOR/subcontractor for breach of contract and other sanctions available to enforce the Wage and Labor Standard Provisions.

4. BREACH OF WAGE AND LABOR STANDARD PROVISIONS

The OWNER reserves the right to terminate this Contract for cause if the Contractor/subcontractors shall knowingly and continuously breach, without timely restitution or cure, any of these governing Wage and Labor Standard Provisions. A knowing and unremedied proven violation of these Wage and Labor Standard Provisions may also be grounds for debarment of the CONTRACTOR/subcontractor from future OWNER contracts for lack of responsibility, as later determined by the OWNER. Recurrent violations, whether remedied or not, will be considered by the General Manager and CEO when assessing the responsibility history of a potential contractor/subcontractor prior to competitive award of future Public Works projects. The general remedies stated in this paragraph 4. above, are not exhaustive and not cumulative, for the OWNER reserves legal and contractual rights to other specific remedies outlined herein below and in other parts of this Contract and as are allowed by applicable OWNER resolutions, State and federal statutes.

5. EMPLOYMENT OF LABORERS/MECHANICS NOT LISTED IN WAGE DETERMINATION DECISION

In the event that a CONTRACTOR/subcontractor discovers that construction of a particular Work element requires a certain employee classification and skill that is not

listed in the Wage Determination Decision contained in the original Contract Documents, CONTRACTOR/subcontractors will make prompt inquiry (before bidding, if possible) to the OWNER identifying that class of laborers/mechanics not listed in the Wage Determination Decision who are intended to be employed, or who are being employed, under the Contract. Using his best judgment and information resources available to him at the time, and any similar prior local or federal decisions, the General Manager and CEO of the OWNER, shall classify said laborers/mechanics by issuing a special local wage determination decision to the CONTRACTOR/subcontractor, which shall be enforced by the OWNER.

6. MINIMUM WAGE

All laborers/mechanics employed to construct the Work governed by this Contract shall be paid not less than weekly the full amount of wages due (minimum hourly base pay and any applicable minimum hourly fringe benefit contribution for all hours worked, including overtime) for the immediately preceding pay period, computed at wage and any fringe rates not less than those contained in the Wage Determination Decision included in this Contract. Only payroll deductions as are mandated by State or federal law, and those legal deductions previously approved in writing by the employee, or as are otherwise permitted by State or federal law, may be withheld by the CONTRACTOR/subcontractor.

Should the CONTRACTOR/subcontractor subscribe to fringe benefit programs for employees, such programs shall be fully approved by the OWNER in adopting a previous U.S. Department of Labor decision on such fringe benefit programs or by applying DOL criteria, in rendering a local decision on the adequacy of the CONTRACTOR's fringe benefit programs. The approved programs shall be in place at the time of OWNER Contract execution and provisions thereof disclosed to the OWNER's Engineer or Wage and Hour Monitor, for legal review prior to Project commencement.

Regular CONTRACTOR/subcontractor contributions made to, or costs incurred for, approved fringe benefit plans, funds or other benefit programs that cover periods of time greater than the one week payroll period (e.g. monthly or quarterly, etc.) shall be prorated by the CONTRACTOR/subcontractor on weekly payroll records to reflect the equivalent value of the hourly and weekly summary of fringe benefits per employee.

7. OVERTIME COMPENSATION ON NON-FEDERALLY FUNDED PROJECTS

No CONTRACTOR/subcontractor contracting for any part of the non-federally funded Contract Work (except for worksite related security guard services), which may require or involve the employment of laborers/mechanics, shall require or permit any laborer/mechanic in any seven (7) calendar day Work period in which he, she is employed on such Work, to Work in excess of 40 hours in such Work period, unless said laborer/mechanic receives compensation at a rate not less than one and one-half times the basic hourly rate of pay for all hours worked in excess of 40 hours in a seven (7) calendar day Work period. Any applicable fringe benefits must be paid for straight time and overtime; however, fringe benefits are not included when computing the overtime rate.

8. PAYMENT OF CASH EQUIVALENT FRINGE BENEFITS

The CONTRACTOR/subcontractor is allowed to pay a minimum hourly cash equivalent of any applicable minimum hourly fringe benefits listed in the Wage Determination Decision, in lieu of the contribution of benefits to a permissible fringe benefit plan, for all hours worked, including overtime. An employee is not allowed to receive less than the local \$8.00 pr. hour minimum living wage or the minimum hourly basic rate of pay specified in the Wage Determination Decision, whichever is greater.

9. WORK CONDUCTED ON HOLIDAYS-NON-FEDERALLY FUNDED PROJECTS

If a laborer/mechanic is employed in the normal course and scope of his or her Work on the jobsite on New Year's Day, Martin Luther King Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, Christmas Day, or the calendar days observed as such in any given year, along with additional OWNER-designated local holidays to be annually determined by OWNER and provided in writing to CONTRACTOR, Work shall be paid for at no less than one and one half (1 1/2) times the regular minimum hourly base pay regardless of the total number of hours the laborer/mechanic has accumulated during the pay period.

10. UNDERPAYMENT OF WAGES OR SALARIES

- a. When a "full investigation" (as called for in and as construed under Texas Government Code Section 2258.001 et seq. and as further generally described in an administrative directive to the OWNER's Engineer and BPUB's Wage & Hour Monitor from the General Manager and CEO entitled "Conducting Wage and Labor Standards Investigations on 100% Non-Federally Funded BPUB Construction Projects", as may be amended) evidences underpayment of wages by CONTRACTOR/subcontractor to laborers/mechanics employed upon the Work covered by this Contract, the OWNER, in addition to such other rights as may be afforded it under State and/or federal law and/or this Contract, shall withhold from the CONTRACTOR, out of any payments (interim progress and /or final) due the CONTRACTOR, so much thereof as the OWNER may consider necessary to secure ultimate payment by the appropriate party to such laborers/mechanics, of full wages required by this Contract, plus possible penalty (See b. below). The amount so withheld, excluding any possible penalty to be retained by the OWNER, may be disbursed at an appropriate time after "full investigation" by the OWNER, for and on behalf of the CONTRACTOR/subcontractor (as may be appropriate), to the respective laborers/mechanics to whom the same is due, or on their behalf to fringe benefit plans, funds, or programs for any type of minimum fringe benefits prescribed in the applicable wage determination decision.
- b. Texas Government Code Section 2258.001 et seq., as amended, states that the CONTRACTOR shall forfeit as a penalty to the OWNER the sum of sixty dollars (\$60.00) for each calendar day, or portion thereof, for each laborer, workman, or mechanic, who is paid less than the said stipulated rate for any Work done under this Contract, whether by the CONTRACTOR himself, or by any subcontractor

working under him. Pursuant to and supplemental to this statutory authority, the OWNER and the CONTRACTOR/subcontractor contractually acknowledge and agree that said sixty dollar (\$60.00) statutory penalty shall be construed by and between the OWNER and the CONTRACTOR/subcontractor as liquidated damages, and not as a penalty, and will apply to any violations of paragraphs 6, 7, or 9 herein, resulting from CONTRACTOR/subcontractor underpayment violations.

- c. If unpaid or underpaid workers cannot be located by the CONTRACTOR or the OWNER after diligent efforts to accomplish same, unpaid or underpaid wages shall be reserved by the OWNER in a special "unfound worker's account" established by the OWNER, for such employees. If after one (1) year from the final acceptance of the Project by the OWNER, workers still cannot be located, in order that the OWNER can make effective interim re-use of the money, such wages and any associated liquidated damages may be used to defray actual costs incurred by the OWNER in attempting to locate said workers, and any remaining monies may then revert back to the OWNER's original funding source for the Project. However, unpaid or underpaid workers for which money was originally reserved are eligible to claim recovery from the OWNER for a period of not-to-exceed three (3) years from the final acceptance of the Project by the OWNER. Recovery after expiration of the three year period is prohibited.

11. DISPLAYING WAGE DETERMINATION DECISIONS/AND NOTICE TO LABORERS/MECHANICS STATEMENT

The applicable Wage Determination Decision as described in the "General Statement" (and as specifically included in the Project Contract), outlining the various worker classifications and mandatory minimum wages and minimum hourly fringe benefit deductions, if any, of laborers/mechanics employed and to be employed upon the Work covered by this Contract, shall be displayed by the CONTRACTOR/subcontractor at the site of Work in a conspicuous and prominent public place, readily and routinely accessible to workmen for the duration of the Project. In addition, the CONTRACTOR/subcontractor agrees with the contents of the following statement, and shall display same, in English and Spanish, near the display of the wage determination decision at the site of Work:

NOTICE TO LABORERS/MECHANICS

Both the OWNER and the CONTRACTOR/subcontractor agree that you must be compensated with not less than the minimum hourly base pay of \$8.00 pr. hour or other greater minimum hourly base pay based upon job classification, and minimum hourly fringe benefit contribution in accordance with the wage rates publicly posted at this jobsite, and as are applicable to the classification of Work you perform.

Additionally, you must be paid not less than one and one-half times your basic hourly rate of pay for any hours worked over 40 in any seven (7) calendar day Work period, and for any Work conducted on New Year's Day, Martin Luther King Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day or the calendar days observed

as such in any given year, along with additional OWNER-designated local holidays to be annually determined by OWNER and provided to CONTRACTOR.

Apprentice and trainee hourly wage rates and ratios apply only to apprentices and trainees recognized under approved Federal, or State, apprenticeship training programs registered with the Bureau of Apprenticeship and Training, U.S. Dept. of Labor.

If you believe that your employer is not paying the appropriate minimum wage for the type of Work you do, you must make direct inquiry to the CONTRACTOR/subcontractor and inquire in writing, within sixty (60) calendar days of your receipt of any allegedly incorrect wage or benefit check or report, to the BPUB(OWNER's) Engineer and/or BPUB Wage & Hour Monitor, 1425 Robinhood Drive, Brownsville, Texas 78520. It is mandatory that you promptly file written inquiry of any allegedly incorrect wage or benefit checks or reports with the BPUB within the sixty (60) calendar day period, so that you do not waive your potential right of recovery under the provisions of the BPUB (OWNER) construction Contract that governs this Project.

Both the OWNER and the Contractor/subcontractor agree that no laborer/mechanic who files a complaint or inquiry concerning alleged underpayment of wages or benefits, shall be discharged by the employer, or in any other manner be discriminated against by the employer, for filing such complaint or inquiry.

12. PAYROLLS & BASIC PAYROLL RECORDS

- a. The CONTRACTOR and each subcontractor shall prepare payroll reports in accordance with the "General Guideline" instructions furnished by the OWNER's Engineer or Wage & Hour Monitor of the BPUB. Such payroll submittals shall contain the name and address of each such employee, his correct labor classification, rate of pay, daily and weekly number of hours worked, any deductions made, and actual basic hourly and fringe benefits paid. The CONTRACTOR shall submit payroll records each week, and no later than seven (7) working days following completion of the workweek being processed, to the OWNER's Engineer or Wage & Hour Monitor, BPUB. These payroll records shall include certified copies of all payrolls of the CONTRACTOR and of his subcontractors, it being understood that the CONTRACTOR shall be responsible for the submission and general mathematical accuracy of payrolls from all of his subcontractors. Each such payroll submittal shall be on forms deemed satisfactory to the OWNER's Engineer or Wage & Hour Monitor, and shall contain a "Weekly Statement of Compliance", as called for by the Contract Documents. Such payrolls will be forwarded to OWNER's Engineer or Wage & Hour Monitor, 1425 Robinhood Drive, Brownsville, Texas 78520.
- b. Copies of payroll submittals and basic supporting payroll records of the CONTRACTOR/subcontractors accounting for all laborers/mechanics employed under the Work covered by this Contract, shall be maintained by CONTRACTOR/subcontractor during the course of the Work, and preserved for a period of three (3) years after completion of the Project. The

CONTRACTOR/subcontractors shall maintain records which demonstrate: any CONTRACTOR/subcontractors commitment to provide fringe benefits to employees as may be mandated by the applicable Wage Determination Decision; that the plan or program is adjudged financially responsible by the appropriate approving authority, (i.e. U.S. Department of Labor, U.S. Department of Treasury, etc.); and that the provisions, policies, certificates, and description of benefits of the plan or program as may be periodically amended, have been clearly communicated in a timely manner and in writing, to the laborers/mechanics affected prior to their performing Work on the Project.

- c. The CONTRACTOR/subcontractor shall make the above records available for inspection, copying, or transcribing by authorized OWNER's Engineer or Wage & Hour Monitor of the BPUB at reasonable times and locations for purposes of monitoring compliance with this Contract.

13. LABOR DISPUTES

The CONTRACTOR/subcontractor shall immediately notify the BPUB General Manager and CEO or his designated representative of any actual or impending CONTRACTOR/subcontractor labor dispute which may affect, or is affecting, the Schedule of the CONTRACTOR's or any other contractor's/subcontractor's Work. In addition, the CONTRACTOR/subcontractor shall consider all appropriate measures to eliminate or minimize the effect of such labor disputes on the Schedule, including but not limited to such measures as: promptly seeking injunctive relief if appropriate; seeking appropriate legal or equitable actions or remedies; taking such measures as establishing a reserved gate, as appropriate; if reasonably feasible, seeking other sources of supply or service; and any other measures that may be appropriately utilized to mitigate or eliminate the jobsite and Scheduling effects of the labor dispute.

14. COMPLAINTS, PROCEEDINGS, OR TESTIMONY BY CONTRACTOR/SUBCONTRACTOR EMPLOYEES

No laborers/mechanics to whom the wage, salary, or other labor standard provisions of this Contract are applicable shall be discharged, or in any other manner discriminated against by the CONTRACTOR/subcontractors, because such employee has filed any formal inquiry or complaint, or instituted or caused to be instituted, any legal or equitable proceeding, or has testified, or is about to testify, in any such proceeding under or relating to the wage and labor standards applicable under this Contract.

15. EMPLOYEE INTERVIEWS TO ASSURE WAGE AND LABOR STANDARD COMPLIANCE

CONTRACTOR/subcontractors shall allow expeditious jobsite entry of the OWNER's Engineer and/or Wage & Hour Monitor displaying and presenting proper BPUB identification credentials to the jobsite superintendent or his representative. While on the jobsite, the OWNER's Engineer and/or Wage & Hour Monitor shall observe all jobsite rules and regulations concerning safety, internal security and fire prevention.

CONTRACTOR/subcontractors shall allow Project employees to be separately and confidentially interviewed at random for a reasonable duration by the OWNER's Engineer and/or Wage & Hour Monitor to facilitate compliance determinations regarding adherence by the CONTRACTOR/subcontractor to these Wage and Labor Standard Provisions.

16. "ANTI-KICKBACK" PROVISION

No person employed in the construction or repair of any BPUB public works Project shall be induced, by any means, to give up to the CONTRACTOR/subcontractor or City of Brownsville or BPUB public official or employee, any part of the hourly and/or fringe benefit compensation to which he or she is otherwise entitled.

17. "FALSE OR DECEPTIVE INFORMATION" PROVISION

Any person employed by the CONTRACTOR/subcontractor in the construction or repair of any BPUB public works project, who is proven to have knowingly and willfully falsified, concealed or covered up by any deceptive trick, scheme, or device a material fact, or made any false, fictitious or fraudulent statement or representation, or made or used any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be permanently removed from the jobsite by the CONTRACTOR/subcontractor. The OWNER reserves the right to terminate this Contract for cause as a result of serious and uncured violations of this provision.

18. EMPLOYMENT OF APPRENTICES/TRAINEES

- a. Apprentices will be permitted to work at less than the predetermined rate for the Work they perform when they are employed and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship & Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship & Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen in any craft classification shall not be greater than the ratio under the registered program. Any employee listed on a payroll at an apprentice wage rate, who is not a trainee as defined in (b) below, or is not registered or otherwise employed as stated above, shall be paid the wage rate for the classification of work he actually performs. The CONTRACTOR/subcontractor is required to furnish to the OWNER'S Engineer or Wage & Hour Monitor of the BPUB, a copy of the certification, along with the payroll record that the employee is first listed on. The wage rate paid apprentices shall be not less than the specified rate in the registered program for the apprentice's level of progress expressed as the appropriate percentage of the journeyman's rate contained in the applicable Wage Determination Decision.

- b. Trainees will be permitted to work at less than the predetermined rate for the Work performed when they are employed pursuant to an individually registered program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen shall not be greater than that permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress. Any employee listed on the payroll at a trainee wage rate, who is not registered and participating in a training plan approved by the Employment and Training Administration, shall be paid not less than the wage rate determined by the classification of Work he actually performs. The CONTRACTOR/subcontractor is required to furnish a copy of the trainee program certification, registration of employee-trainees, ratios and wage rates prescribed in the program, along with the payroll record that the employee is first listed on, to the OWNER's Engineer or Wage & Hour Monitor of the BPUB. In the event the Employment and Training Administration withdraws approval of a training program, the CONTRACTOR/subcontractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the Work performed until an acceptable program is approved by the Employment and Training Administration.
- c. Paragraphs 18.a. and b. above shall not operate to exclude training programs approved by the OFCCP, United States Department of Labor and as adopted by the Associated General Contractors (AGC) of Texas, Highway, Heavy, Utilities and Industrial Branch. Guidelines for these training programs shall be the same as those established for federally funded projects. This sub-paragraph 18.c. shall not apply to those portions of a project deemed to be building construction.
- d. RATIOS, APPRENTICE TO JOURNEYMAN:

The Ratio of Apprentice to Journeyman for this Project shall be the same as the Ratio permitted under the plan approved by the Employment and Training Administration, Bureau of Apprenticeship and Training, U.S. Department of Labor, by craft. A copy of the allowable Ratios is included with the applicable Wage Determination Decision in the Specifications for this Project.

When a "full investigation" (as called for in, and as construed under Texas Government Code Section 2258.001 et. seq., and as further generally described in an administrative directive to the OWNER's Engineer and BPUB's Wage & Hour Monitor from the General Manager entitled "Conducting Wage and Labor Standards Investigations on 100% Non-Federally Funded BPUB Construction Projects", as may be amended) evidences a violation of the Apprentice or Trainee to Journeyman ratios effective for CONTRACTOR/subcontractor employees working on this Contract, the POWNER, in addition to such other rights as may be afforded it under State and/or federal law and/or other sections of this Contract (especially paragraph 10, of these Supplementary General Conditions

“Underpayment of Wages”), shall withhold from the CONTRACTOR, out of any payments (interim progress and/or final) due the CONTRACTOR, the liquidated damages (not a penalty) sum of three hundred dollars (\$300.00) for each calendar day, or portion thereof, for each certified Apprentice or Trainee employee assigned to a Journeyman that exceeds the maximum allowable Apprentice/Trainee to Journeyman ratio stipulated for any Work done under this Contract, whether by the CONTRACTOR himself, or by any subcontractor working under him.

19. JOBSITE CONDITIONS

CONTRACTOR/subcontractor will not allow any person employed for the Project to work in surroundings or under construction conditions which are unsanitary, unhealthy, hazardous, or dangerous as governed by industry standards and appropriate City of Brownsville, State and federal statutes, ordinances, and regulatory guidelines.

20. EMPLOYMENT OF CERTAIN PERSONS PROHIBITED

- a. The CONTRACTOR/subcontractor shall knowingly only employ persons of appropriate ages commensurate with the degree of required skill, strength, maturity and judgment associated with the activity to be engaged in, but not less than the age of fourteen (14) years, as governed by Chapter 51 "Employment of Children", Texas Labor Code, (Vernon's Texas Codes Annotated) (as may be amended), and Texas Department of Labor and Standards rulings and interpretations associated with that statute. It is hereby noted that in some circumstances generally governed by this section, a federal statute (see: Fair Labor Standards Act, 29 USCS Section 212; Volume 6A of the Bureau of National Affairs Wage Hour Manual at Paragraph 96:1; "Child Labor Requirements in Nonagricultural Occupations" WH Publication 1330, July 1978 as may be amended), could pre-empt the Texas Statute and therefore be the controlling law on this subject. The CONTRACTOR/subcontractor should seek clarification from State and federal agencies and CONTRACTOR's legal counsel when hiring adolescent employees for particular job classifications.
- b. Prohibited persons not to be employed are also those persons who, at the time of employment for this Contract, are serving sentence in a penal or correctional institution, except that prior approval by the BPUB General Manager is required to employ any person participating in a supervised work release or furlough program that is sanctioned by appropriate State or federal correctional agencies.
- c. The CONTRACTOR/subcontractors shall be responsible for compliance with the provisions of the "Immigration Reform and Control Act of 1986" Public Law 99-603, and any related State enabling or implementing statutes, especially as they in combination apply to the unlawful employment of aliens and unfair immigration-related employment practices affecting this Contract.

21. PROVISIONS TO BE INCLUDED IN SUBCONTRACTS

The CONTRACTOR shall cause these Wage and Labor Standard Provisions, or reasonably similar contextual adaptations hereof, and any other appropriate State and federal labor provisions, to be inserted in all subcontracts relative to the Work to bind subcontractors to the same Wage and Labor Standards as contained in these terms of the General Conditions and other Contract Documents, insofar as applicable to the Work of subcontractors or sub-tier subcontractors, and to give the CONTRACTOR similar, if not greater, general contractual authority over the subcontractor, or sub-tier subcontractors, as the OWNER may exercise over the CONTRACTOR.

General Decision Number: TX190003 01/04/2019 TX3

Superseded General Decision Number: TX20180008

State: Texas

Construction Types: Heavy and Highway

Counties: Cameron, Hidalgo and Webb Counties in Texas.

HEAVY & HIGHWAY CONSTRUCTION PROJECTS

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.60 for calendar year 2019 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.60 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2019. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/04/2019

* SUTX2011-003 08/02/2011

	Rates	Fringes
CEMENT MASON/CONCRETE		
FINISHER (Paving & Structures).....	\$ 12.46	
FORM BUILDER/FORM SETTER		
(Structures).....	\$ 12.30	
FORM SETTER (Paving & Curb).....	\$ 12.16	
LABORER		
Asphalt Raker.....	\$ 10.61	
Flagger.....	\$ 9.10	
Laborer, Common.....	\$ 9.86	

	Rates	Fringes
Laborer, Utility.....	\$ 11.53	
Pipelayer.....	\$ 11.87	
Work Zone Barricade		
Servicer.....	\$ 12.88	

POWER EQUIPMENT OPERATOR:

Asphalt Distributor.....	\$ 13.48
Asphalt Paving Machine.....	\$ 12.25
Broom or Sweeper.....	\$ 10.33
Crane, Lattice Boom 80 Tons or Less.....	\$ 14.39
Crawler Tractor.....	\$ 16.63
Excavator, 50,000 lbs or less.....	\$ 12.56
Excavator, over 50,000 lbs.....	\$ 15.23
Foundation Drill, Truck Mounted.....	\$ 16.86
Front End Loader Operator, Over 3 CY.....	\$ 13.69
Front End Loader, 3 CY or less.....	\$ 13.49
Loader/Backhoe.....	\$ 12.77
Mechanic.....	\$ 15.47
Milling Machine.....	\$ 14.64
Motor Grader Operator, Rough.....	\$ 14.62
Motor Grader, Fine Grade.....	\$ 16.52
Scraper.....	\$ 11.07

Servicer.....\$ 12.34

Steel Worker (Reinforcing).....\$ 14.07

TRUCK DRIVER

Lowboy-Float.....	\$ 13.63
Single Axle.....	\$ 10.82
Single or Tandem Axle Dump.....	\$ 14.53
Tandem Axle Tractor with Semi Trailer.....	\$ 12.12

WELDER.....\$ 14.02

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

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 Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. 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.

=====

END OF GENERAL DECISION

REQUIRED FORMS

FORMS CHECKLIST

The following documents are to be submitted as a part of the Bid/RFP/RFQ document

NAME	FORM DESCRIPTION	SUBMITTED WITH BID	
		YES	NO
Required Forms (if applicable)	Acknowledgement Form	<input type="checkbox"/>	<input type="checkbox"/>
	Debarment Certificate	<input type="checkbox"/>	<input type="checkbox"/>
	Ethic Statement	<input type="checkbox"/>	<input type="checkbox"/>
	Conflict of Interest Questionnaire	<input type="checkbox"/>	<input type="checkbox"/>
	W9 or W8 Form	<input type="checkbox"/>	<input type="checkbox"/>
	Direct Deposit Form	<input type="checkbox"/>	<input type="checkbox"/>
	Residence Certification Form	<input type="checkbox"/>	<input type="checkbox"/>
Special Instructions (if applicable)	Bid Schedule/Cost sheet completed and signed	<input type="checkbox"/>	<input type="checkbox"/>
	Cashier Check or Bid Bond of 5% of Total Amount of Bid	<input type="checkbox"/>	<input type="checkbox"/>
	OSHA 300 Log	<input type="checkbox"/>	<input type="checkbox"/>
	Contractor Pre-Bid Disclosure completed, signed and notarized	<input type="checkbox"/>	<input type="checkbox"/>
	Sub-Contractor Pre-Bid Disclosure completed, signed, and notarized	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
References	Complete the Previous Customer Reference Worksheet for each reference provided	<input type="checkbox"/>	<input type="checkbox"/>
Addenda		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>

Prospective Bidders are respectfully reminded to completely read and thoroughly respond to the BPUB Instructions for Bidders and Pre-Bid Disclosure Statement. When BPUB evaluates the Bids, it reviews indices regarding the prospective contractors' responsibility to perform the project based upon prior job performances for BPUB and other public owners. Additionally, BPUB carefully reviews the prospective contractors' responsiveness to the BPUB Bid Advertisement. Bidders

should thoroughly check their submittal for completeness prior to responding to BPUB. Do not imbalance your Bid line items to overload portions of the work. Remember to answer all written questions in the Pre-Bid Disclosure Statement and then notarize it when signing. Bidders are often required to submit OSHA 300 Logs from prior job performance records as well. BPUB can, has, and will reject Bids that fail the responsibility and/or responsiveness standards so as to protect the integrity of the bidding process for all participants. The Bidding community's compliance with these guideline standards will be appreciated by the BPUB.

ETHICS STATEMENT
(Complete and return with bid)

The undersigned bidder, by signing and executing this bid, certifies and represents to the Brownsville Public Utilities Board that bidder has not offered, conferred or agreed to confer any pecuniary benefit, as defined by (1.07 (a) (6) of the Texas Penal Code, or any other thing of value as consideration for the receipt of information or any special treatment of advantage relating to this bid; the bidder also certifies and represents that the bidder has not offered, conferred or agreed to confer any pecuniary benefit or other thing of value as consideration for the recipient's decision, opinion, recommendation, vote or other exercise of discretion concerning this bid, the bidder certifies and represents that bidder has neither coerced nor attempted to influence the exercise of discretion by any officer, trustee, agent or employee of the Brownsville Public Utilities Board concerning this bid on the basis of any consideration not authorized by law; the bidder also certifies and represents that bidder has not received any information not available to other bidders so as to give the undersigned a preferential advantage with respect to this bid; the bidder further certifies and represents that bidder has not violated any state, federal, or local law, regulation or ordinance relating to bribery, improper influence, collusion or the like and that bidder will not in the future offer, confer, or agree to confer any pecuniary benefit or other thing of value of any officer, trustee, agent or employee of the Brownsville Public Utilities Board in return for the person having exercised their person's official discretion, power or duty with respect to this bid; the bidder certifies and represents that it has not now and will not in the future offer, confer, or agree to confer a pecuniary benefit or other thing of value to any officer, trustee, agent, or employee of the Brownsville Public Utilities Board in connection with information regarding this bid, the submission of this bid, the award of this bid or the performance, delivery or sale pursuant to this bid.

THE VENDOR SHALL DEFEND, INDEMNIFY, AND HOLD HARMLESS THE CITY OF BROWNSVILLE AND THE BROWNSVILLE PUBLIC UTILITIES BOARD, ALL OF THEIR OFFICERS, AGENTS AND EMPLOYEES FROM AND AGAINST ALL CLAIMS, ACTIONS, SUITS, DEMANDS, PROCEEDING, COSTS, DAMAGES, AND LIABILITIES, ARISING OUT OF, CONNECTED WITH, OR RESULTING FROM ANY ACTS OR OMISSIONS OF CONTRACTOR OR ANY AGENT, EMPLOYEE, SUBCONTRACTOR, OR SUPPLIER OF CONTRACTOR IN THE EXECUTION OR PERFORMANCE OF THIS BID.

I have read all of the specifications and general bid requirements and do hereby certify that all items submitted meet specifications.

COMPANY: _____

AGENT NAME: _____

AGENT SIGNATURE: _____

ADDRESS: _____

CITY: _____

STATE: _____ ZIP CODE: _____

TELEPHONE: _____ TELEFAX: _____

FEDERAL ID#: _____ AND/OR SOCIAL SECURITY #: _____

DEVIATIONS FROM SPECIFICATIONS IF ANY:

NOTE: QUESTIONS AND CONCERNS FROM PROSPECTIVE CONTRACTORS SHOULD BE RAISED WITH OWNER AND ITS CONSULTANT (IF APPLICABLE) AND RESOLVED IF POSSIBLE, PRIOR TO THE PROPOSAL SUBMITTAL DATE. ANY LISTED DEVIATIONS IN A FINALLY SUBMITTED PROPOSAL MAY ALLOW THE OWNER TO REJECT A PROPOSAL AS NON-RESPONSIVE.

DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS
(Complete and Return with Bid)

Name of Entity: _____

The prospective participant certifies to the best of their knowledge and belief that they and their principals:

- a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- b) Have not within a three year period preceding this bid been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
- c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, Local) with commission of any of the offenses enumerated in paragraph (b) of this certification; and
- d) Have not within a three year period preceding this bid had one or more public transactions (Federal, State, Local) terminated for cause or default.

I understand that a false statement on this certification may be grounds for rejection of this bid or termination of the award. In addition, under 18 USC Section 1001, a false statement may result in a fine up to a \$10,000.00 or imprisonment for up to five (5) years, or both.

Name and Title of Authorized Representative (Typed)

Signature of Authorized Representative

Date

I am unable to certify to the above statements. My explanation is attached.

THIS FORM MUST BE COMPLETED IN ITS ENTIRETY & SUBMITTED WITH BID RESPONSE

CONFLICT OF INTEREST QUESTIONNAIRE For vendor doing business with local governmental entity		FORM CIQ
<p>This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.</p> <p>This questionnaire is being filed in accordance with Chapter 176, 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).</p> <p>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.</p> <p>A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.</p>	OFFICE USE ONLY	
<p>1 Name of vendor who has a business relationship with local governmental entity.</p>	Date Received	
<p>2 <input type="checkbox"/> 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.)</p>		
<p>3 Name of local government officer about whom the information is being disclosed.</p> <p style="text-align: center;">_____</p> <p style="text-align: center;">Name of Officer</p>		
<p>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.</p> <p style="margin-left: 40px;">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?</p> <p style="margin-left: 80px;"> <input type="checkbox"/> Yes <input type="checkbox"/> No </p> <p style="margin-left: 40px;">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?</p> <p style="margin-left: 80px;"> <input type="checkbox"/> Yes <input type="checkbox"/> No </p>		
<p>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.</p>		
<p>6 <input type="checkbox"/> 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).</p>		
<p>7</p> <p style="text-align: center;"> _____ Signature of vendor doing business with the governmental entity </p> <p style="text-align: right; margin-right: 100px;"> _____ Date </p>		

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.

BROWNSVILLE PUBLIC UTILITIES BOARD
RESIDENCE CERTIFICATION

In accordance with Art. 601g, as passed by the 1985 Texas Legislature, the following will apply. The pertinent portion of the Act has been extracted and is as follows:

Section 1. (a)

(1) "Nonresident bidder" means a bidder whose principal place of business is not in this state, but excludes a contractor whose ultimate parent company or majority owner has its principal place of business in this state.

(2) "Texas resident bidder " means a bidder whose principal place of business is in this state, and includes a contractor whose ultimate parent company or majority owner has its principal place of business in this state.

Section 1. (b)

The state or governmental agency of the state may not award a contract for general construction, improvements, services, or public works projects or purchases of supplies, materials or equipment to a nonresident bidder unless the nonresident's bid is lower than the lowest bid submitted by a responsible Texas resident bidder by the same amount that a Texas resident bidder would be required to underbid a nonresident bidder to obtain a comparable contract in the state in which the nonresident's principal place of business is located.

I certify that
(Company Name) is a **resident Texas bidder** as defined in Art. 601g.

Signature: _____

Print Name: _____

I certify that
(Company Name) is a **nonresident bidder** as defined in Art. 601g. and our principal place of
business is: _____

(City and State)

Signature: _____

Print Name: _____

Previous Customer Reference Worksheet

Name of Customer:		Customer Contact:
Customer Address:		Customer Phone Number:
		Customer Email:

Name of Company Performing Referenced Work:

What was the Period of Performance? From:		What was the Final Acceptance Date?
To:		
Dollar Value of Contract? \$ _____		What Type of Contract? <input type="checkbox"/> Firm Fixed Price <input type="checkbox"/> Time and Material <input type="checkbox"/> Not to Exceed <input type="checkbox"/> Cost Plus Fixed Fee <input type="checkbox"/> Other, Specify: _____

Provide a brief description of the work performed for this customer (add additional page if required)



Direct Deposit Authorization Form

Dear Vendor,

The Brownsville Public Utilities Board (BPUB) is pleased to provide our vendors with the opportunity to receive payments directly through an Automated Clearing House (ACH). The ACH is an automated process that permits funds to be directly transferred to your financial institution. ACH will alleviate lost checks in the mail, potential mail fraud, and also expedite your payments upon payment terms. Whenever you enroll in ACH, the email address you provide below is automatically setup to receive electronic notifications when BPUB processes an ACH payment for you. If you are interested in this payment option please complete the information requested in this form and fax or mail back as indicated below. All fields are required.

New Application
 Request Change
 Request Cancellation

Vendor Information

Business Name: _____
 Tax ID Number: _____
 Remit to Address: _____
 City: _____ State: _____ Zip Code: _____

Bank Information

Bank Name: _____
 Bank Routing (ABA) Number (9 digit number): _____
 Bank Account Number: _____

Please enclose one of the following for verification: <input type="checkbox"/> Voided Check <input type="checkbox"/> Specification form from bank	Check One: <input type="checkbox"/> Checking Account <input type="checkbox"/> Savings Account
---	---

Authorization

I, _____, as an authorized signer for _____ do hereby authorize the BPUB to deposit payments by ACH directly into the above specified bank account and request payment notification to be sent to the recipient e-mail address below.

 Authorized Signature Title

 Date Telephone Number Electronic Notification E-Mail Address

Mail or Fax to:
 Brownsville Public Utilities Board Attn: Finance Department
 P.O. Box 3270 Brownsville, TX 78523-3270
 Fax: (956) 574-6117

Request for Taxpayer Identification Number and Certification

**Give Form to the
requester. Do not
send to the IRS.**

▶ Go to www.irs.gov/FormW9 for instructions and the latest information.

Print or type.
See Specific Instructions on page 3.

1 Name (as shown on your income tax return). Name is required on this line; do not leave this line blank.	
2 Business name/disregarded entity name, if different from above	
3 Check appropriate box for federal tax classification of the person whose name is entered on line 1. Check only one of the following seven boxes. <input type="checkbox"/> Individual/sole proprietor or single-member LLC <input type="checkbox"/> C Corporation <input type="checkbox"/> S Corporation <input type="checkbox"/> Partnership <input type="checkbox"/> Trust/estate <input type="checkbox"/> Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=Partnership) ▶ _____ <small>Note: Check the appropriate box in the line above for the tax classification of the single-member owner. Do not check LLC if the LLC is classified as a single-member LLC that is disregarded from the owner unless the owner of the LLC is another LLC that is not disregarded from the owner for U.S. federal tax purposes. Otherwise, a single-member LLC that is disregarded from the owner should check the appropriate box for the tax classification of its owner.</small> <input type="checkbox"/> Other (see instructions) ▶ _____	4 Exemptions (codes apply only to certain entities, not individuals; see instructions on page 3): Exempt payee code (if any) _____ Exemption from FATCA reporting code (if any) _____ <small>(Applies to accounts maintained outside the U.S.)</small>
5 Address (number, street, and apt. or suite no.) See instructions.	Requester's name and address (optional)
6 City, state, and ZIP code	
7 List account number(s) here (optional)	

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on line 1 to avoid backup withholding. For individuals, this is generally your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the instructions for Part I, later. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN*, later.

Note: If the account is in more than one name, see the instructions for line 1. Also see *What Name and Number To Give the Requester* for guidelines on whose number to enter.

Social security number										
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; border: 1px solid black; height: 20px;"></td> <td style="width: 5%; text-align: center;">-</td> <td style="width: 25%; border: 1px solid black; height: 20px;"></td> <td style="width: 5%; text-align: center;">-</td> <td style="width: 40%; border: 1px solid black; height: 20px;"></td> </tr> </table>		-		-						
	-		-							
or										
Employer identification number										
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> <td style="width: 10%; border: 1px solid black; height: 20px;"></td> </tr> </table>										

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me); and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding; and
3. I am a U.S. citizen or other U.S. person (defined below); and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions for Part II, later.

Sign Here	Signature of U.S. person ▶	Date ▶
------------------	----------------------------	--------

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future developments. For the latest information about developments related to Form W-9 and its instructions, such as legislation enacted after they were published, go to www.irs.gov/FormW9.

Purpose of Form

An individual or entity (Form W-9 requester) who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) which may be your social security number (SSN), individual taxpayer identification number (ITIN), adoption taxpayer identification number (ATIN), or employer identification number (EIN), to report on an information return the amount paid to you, or other amount reportable on an information return. Examples of information returns include, but are not limited to, the following.

- Form 1099-INT (interest earned or paid)

- Form 1099-DIV (dividends, including those from stocks or mutual funds)
- Form 1099-MISC (various types of income, prizes, awards, or gross proceeds)
- Form 1099-B (stock or mutual fund sales and certain other transactions by brokers)
- Form 1099-S (proceeds from real estate transactions)
- Form 1099-K (merchant card and third party network transactions)
- Form 1098 (home mortgage interest), 1098-E (student loan interest), 1098-T (tuition)
- Form 1099-C (canceled debt)
- Form 1099-A (acquisition or abandonment of secured property)

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN.

If you do not return Form W-9 to the requester with a TIN, you might be subject to backup withholding. See What is backup withholding, later.

**Certificate of Status of Beneficial Owner for
 United States Tax Withholding and Reporting (Entities)**

▶ For use by entities. Individuals must use Form W-8BEN. ▶ Section references are to the Internal Revenue Code.
 ▶ Go to www.irs.gov/FormW8BENE for instructions and the latest information.
 ▶ Give this form to the withholding agent or payer. Do not send to the IRS.

OMB No. 1545-1621

Do NOT use this form for:

- U.S. entity or U.S. citizen or resident W-9
- A foreign individual W-8BEN (Individual) or Form 8233
- A foreign individual or entity claiming that income is effectively connected with the conduct of trade or business within the U.S. (unless claiming treaty benefits) W-8ECI
- A foreign partnership, a foreign simple trust, or a foreign grantor trust (unless claiming treaty benefits) (see instructions for exceptions) W-8IMY
- A foreign government, international organization, foreign central bank of issue, foreign tax-exempt organization, foreign private foundation, or government of a U.S. possession claiming that income is effectively connected U.S. income or that is claiming the applicability of section(s) 115(2), 501(c), 892, 895, or 1443(b) (unless claiming treaty benefits) (see instructions for other exceptions) W-8ECI or W-8EXP
- Any person acting as an intermediary (including a qualified intermediary acting as a qualified derivatives dealer) W-8IMY

Instead use Form:

Part I Identification of Beneficial Owner

1 Name of organization that is the beneficial owner	2 Country of incorporation or organization															
3 Name of disregarded entity receiving the payment (if applicable, see instructions)																
4 Chapter 3 Status (entity type) (Must check one box only): <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> Corporation</td> <td><input type="checkbox"/> Disregarded entity</td> <td><input type="checkbox"/> Partnership</td> </tr> <tr> <td><input type="checkbox"/> Simple trust</td> <td><input type="checkbox"/> Grantor trust</td> <td><input type="checkbox"/> Complex trust</td> </tr> <tr> <td><input type="checkbox"/> Estate</td> <td><input type="checkbox"/> Government</td> <td></td> </tr> <tr> <td><input type="checkbox"/> Central Bank of Issue</td> <td><input type="checkbox"/> Tax-exempt organization</td> <td><input type="checkbox"/> Private foundation</td> </tr> <tr> <td><input type="checkbox"/> International organization</td> <td></td> <td></td> </tr> </table> <p>If you entered disregarded entity, partnership, simple trust, or grantor trust above, is the entity a hybrid making a treaty claim? If "Yes" complete Part III. <input type="checkbox"/> Yes <input type="checkbox"/> No</p>		<input type="checkbox"/> Corporation	<input type="checkbox"/> Disregarded entity	<input type="checkbox"/> Partnership	<input type="checkbox"/> Simple trust	<input type="checkbox"/> Grantor trust	<input type="checkbox"/> Complex trust	<input type="checkbox"/> Estate	<input type="checkbox"/> Government		<input type="checkbox"/> Central Bank of Issue	<input type="checkbox"/> Tax-exempt organization	<input type="checkbox"/> Private foundation	<input type="checkbox"/> International organization		
<input type="checkbox"/> Corporation	<input type="checkbox"/> Disregarded entity	<input type="checkbox"/> Partnership														
<input type="checkbox"/> Simple trust	<input type="checkbox"/> Grantor trust	<input type="checkbox"/> Complex trust														
<input type="checkbox"/> Estate	<input type="checkbox"/> Government															
<input type="checkbox"/> Central Bank of Issue	<input type="checkbox"/> Tax-exempt organization	<input type="checkbox"/> Private foundation														
<input type="checkbox"/> International organization																
5 Chapter 4 Status (FATCA status) (See instructions for details and complete the certification below for the entity's applicable status.) <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Nonparticipating FFI (including an FFI related to a Reporting IGA FFI other than a deemed-compliant FFI, participating FFI, or exempt beneficial owner). <input type="checkbox"/> Participating FFI. <input type="checkbox"/> Reporting Model 1 FFI. <input type="checkbox"/> Reporting Model 2 FFI. <input type="checkbox"/> Registered deemed-compliant FFI (other than a reporting Model 1 FFI, sponsored FFI, or nonreporting IGA FFI covered in Part XII). See instructions. <input type="checkbox"/> Sponsored FFI. Complete Part IV. <input type="checkbox"/> Certified deemed-compliant nonregistering local bank. Complete Part V. <input type="checkbox"/> Certified deemed-compliant FFI with only low-value accounts. Complete Part VI. <input type="checkbox"/> Certified deemed-compliant sponsored, closely held investment vehicle. Complete Part VII. <input type="checkbox"/> Certified deemed-compliant limited life debt investment entity. Complete Part VIII. <input type="checkbox"/> Certain investment entities that do not maintain financial accounts. Complete Part IX. <input type="checkbox"/> Owner-documented FFI. Complete Part X. <input type="checkbox"/> Restricted distributor. Complete Part XI. </td> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Nonreporting IGA FFI. Complete Part XII. <input type="checkbox"/> Foreign government, government of a U.S. possession, or foreign central bank of issue. Complete Part XIII. <input type="checkbox"/> International organization. Complete Part XIV. <input type="checkbox"/> Exempt retirement plans. Complete Part XV. <input type="checkbox"/> Entity wholly owned by exempt beneficial owners. Complete Part XVI. <input type="checkbox"/> Territory financial institution. Complete Part XVII. <input type="checkbox"/> Excepted nonfinancial group entity. Complete Part XVIII. <input type="checkbox"/> Excepted nonfinancial start-up company. Complete Part XIX. <input type="checkbox"/> Excepted nonfinancial entity in liquidation or bankruptcy. Complete Part XX. <input type="checkbox"/> 501(c) organization. Complete Part XXI. <input type="checkbox"/> Nonprofit organization. Complete Part XXII. <input type="checkbox"/> Publicly traded NFFE or NFFE affiliate of a publicly traded corporation. Complete Part XXIII. <input type="checkbox"/> Excepted territory NFFE. Complete Part XXIV. <input type="checkbox"/> Active NFFE. Complete Part XXV. <input type="checkbox"/> Passive NFFE. Complete Part XXVI. <input type="checkbox"/> Excepted inter-affiliate FFI. Complete Part XXVII. <input type="checkbox"/> Direct reporting NFFE. <input type="checkbox"/> Sponsored direct reporting NFFE. Complete Part XXVIII. <input type="checkbox"/> Account that is not a financial account. </td> </tr> </table>		<input type="checkbox"/> Nonparticipating FFI (including an FFI related to a Reporting IGA FFI other than a deemed-compliant FFI, participating FFI, or exempt beneficial owner). <input type="checkbox"/> Participating FFI. <input type="checkbox"/> Reporting Model 1 FFI. <input type="checkbox"/> Reporting Model 2 FFI. <input type="checkbox"/> Registered deemed-compliant FFI (other than a reporting Model 1 FFI, sponsored FFI, or nonreporting IGA FFI covered in Part XII). See instructions. <input type="checkbox"/> Sponsored FFI. Complete Part IV. <input type="checkbox"/> Certified deemed-compliant nonregistering local bank. Complete Part V. <input type="checkbox"/> Certified deemed-compliant FFI with only low-value accounts. Complete Part VI. <input type="checkbox"/> Certified deemed-compliant sponsored, closely held investment vehicle. Complete Part VII. <input type="checkbox"/> Certified deemed-compliant limited life debt investment entity. Complete Part VIII. <input type="checkbox"/> Certain investment entities that do not maintain financial accounts. Complete Part IX. <input type="checkbox"/> Owner-documented FFI. Complete Part X. <input type="checkbox"/> Restricted distributor. Complete Part XI.	<input type="checkbox"/> Nonreporting IGA FFI. Complete Part XII. <input type="checkbox"/> Foreign government, government of a U.S. possession, or foreign central bank of issue. Complete Part XIII. <input type="checkbox"/> International organization. Complete Part XIV. <input type="checkbox"/> Exempt retirement plans. Complete Part XV. <input type="checkbox"/> Entity wholly owned by exempt beneficial owners. Complete Part XVI. <input type="checkbox"/> Territory financial institution. Complete Part XVII. <input type="checkbox"/> Excepted nonfinancial group entity. Complete Part XVIII. <input type="checkbox"/> Excepted nonfinancial start-up company. Complete Part XIX. <input type="checkbox"/> Excepted nonfinancial entity in liquidation or bankruptcy. Complete Part XX. <input type="checkbox"/> 501(c) organization. Complete Part XXI. <input type="checkbox"/> Nonprofit organization. Complete Part XXII. <input type="checkbox"/> Publicly traded NFFE or NFFE affiliate of a publicly traded corporation. Complete Part XXIII. <input type="checkbox"/> Excepted territory NFFE. Complete Part XXIV. <input type="checkbox"/> Active NFFE. Complete Part XXV. <input type="checkbox"/> Passive NFFE. Complete Part XXVI. <input type="checkbox"/> Excepted inter-affiliate FFI. Complete Part XXVII. <input type="checkbox"/> Direct reporting NFFE. <input type="checkbox"/> Sponsored direct reporting NFFE. Complete Part XXVIII. <input type="checkbox"/> Account that is not a financial account.													
<input type="checkbox"/> Nonparticipating FFI (including an FFI related to a Reporting IGA FFI other than a deemed-compliant FFI, participating FFI, or exempt beneficial owner). <input type="checkbox"/> Participating FFI. <input type="checkbox"/> Reporting Model 1 FFI. <input type="checkbox"/> Reporting Model 2 FFI. <input type="checkbox"/> Registered deemed-compliant FFI (other than a reporting Model 1 FFI, sponsored FFI, or nonreporting IGA FFI covered in Part XII). See instructions. <input type="checkbox"/> Sponsored FFI. Complete Part IV. <input type="checkbox"/> Certified deemed-compliant nonregistering local bank. Complete Part V. <input type="checkbox"/> Certified deemed-compliant FFI with only low-value accounts. Complete Part VI. <input type="checkbox"/> Certified deemed-compliant sponsored, closely held investment vehicle. Complete Part VII. <input type="checkbox"/> Certified deemed-compliant limited life debt investment entity. Complete Part VIII. <input type="checkbox"/> Certain investment entities that do not maintain financial accounts. Complete Part IX. <input type="checkbox"/> Owner-documented FFI. Complete Part X. <input type="checkbox"/> Restricted distributor. Complete Part XI.	<input type="checkbox"/> Nonreporting IGA FFI. Complete Part XII. <input type="checkbox"/> Foreign government, government of a U.S. possession, or foreign central bank of issue. Complete Part XIII. <input type="checkbox"/> International organization. Complete Part XIV. <input type="checkbox"/> Exempt retirement plans. Complete Part XV. <input type="checkbox"/> Entity wholly owned by exempt beneficial owners. Complete Part XVI. <input type="checkbox"/> Territory financial institution. Complete Part XVII. <input type="checkbox"/> Excepted nonfinancial group entity. Complete Part XVIII. <input type="checkbox"/> Excepted nonfinancial start-up company. Complete Part XIX. <input type="checkbox"/> Excepted nonfinancial entity in liquidation or bankruptcy. Complete Part XX. <input type="checkbox"/> 501(c) organization. Complete Part XXI. <input type="checkbox"/> Nonprofit organization. Complete Part XXII. <input type="checkbox"/> Publicly traded NFFE or NFFE affiliate of a publicly traded corporation. Complete Part XXIII. <input type="checkbox"/> Excepted territory NFFE. Complete Part XXIV. <input type="checkbox"/> Active NFFE. Complete Part XXV. <input type="checkbox"/> Passive NFFE. Complete Part XXVI. <input type="checkbox"/> Excepted inter-affiliate FFI. Complete Part XXVII. <input type="checkbox"/> Direct reporting NFFE. <input type="checkbox"/> Sponsored direct reporting NFFE. Complete Part XXVIII. <input type="checkbox"/> Account that is not a financial account.															
6 Permanent residence address (street, apt. or suite no., or rural route). Do not use a P.O. box or in-care-of address (other than a registered address). <table style="width: 100%; border: none;"> <tr> <td style="width: 65%; border: none;">City or town, state or province. Include postal code where appropriate.</td> <td style="width: 35%; border: none;">Country</td> </tr> </table>		City or town, state or province. Include postal code where appropriate.	Country													
City or town, state or province. Include postal code where appropriate.	Country															
7 Mailing address (if different from above) <table style="width: 100%; border: none;"> <tr> <td style="width: 65%; border: none;">City or town, state or province. Include postal code where appropriate.</td> <td style="width: 35%; border: none;">Country</td> </tr> </table>		City or town, state or province. Include postal code where appropriate.	Country													
City or town, state or province. Include postal code where appropriate.	Country															
8 U.S. taxpayer identification number (TIN), if required	9a GIIN															
10 Reference number(s) (see instructions)																
b Foreign TIN																

Note: Please complete remainder of the form including signing the form in Part XXX.

For Paperwork Reduction Act Notice, see separate instructions.

Cat. No. 59689N

Form **W-8BEN-E** (Rev. 7-2017)

BPUB TECHNICAL SPECIFICATIONS

SECTION 01010
SUMMARY OF WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and Contract documents, including Division 0 and Division 1 Contract requirements and technical Specifications.

1.02 SCOPE OF WORK

- A. This section describes the Project in general and provides an overview of the extent of the Work to be performed by the CONTRACTOR. Detailed requirements and extent of Work is stated in the applicable Specification Sections and shown on the Drawings. CONTRACTOR shall, except as otherwise specifically stated herein or in any applicable part of these Contract Documents, provide and pay for all labor, materials, equipment, tools, construction equipment, and other facilities and services necessary for proper execution, testing, and completion of the Work.
- B. Any part or item of the Work which is reasonably implied or normally required to make the installation satisfactorily operable shall be performed by the CONTRACTOR and the expense thereof shall be included in the applicable unit prices or lump sum prices bid for the Work. It is the intent of these Specifications to provide the OWNER with the complete system. All miscellaneous appurtenances and other items of Work that are incidental to meeting the intent of the Specifications shall be considered as having been included in the applicable unit prices or lump sum prices bid for the Work even though these appurtenances and items may not be specifically called for in the Bid Documents.
- C. The Work shall include furnishing all tools, labor, materials, equipment, spare parts and miscellaneous items necessary for the complete construction of the following:
 - 1. Furnishing, installing, jointing and testing of all water pipe and equipment, including water pipe fittings, valves, water appurtenances, transfer pump, transfer pump motor, electrical equipment work and all associated items with the installation of the Transfer Pump #3 project as shown on the contract documents, including plans and specifications; as directed by the engineer.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Execute all Work, including excavation, installing pipe and backfill, constructing or installing lift station wet wells and associated buildings and odor control, installing electrical equipment, and miscellaneous site work, concrete and testing. The Work of this Contract is specified on the Drawings and in the Technical Specifications listed in the Table of Contents.

- B. Secure all construction-related permits, other than those provided by OWNER, and pay for the same.
- C. Arrange for the necessary temporary water service and pay for this service and all water consumed during the construction Work.
- D. Provide adequate temporary sanitary facilities.

1.04 TRAFFIC CONTROL (RESERVED)

- A. Develop and submit a traffic control plan which will show both day and night time operations for the installation of the lift stations, pipelines, and associated improvements in conformance with the current edition of the Texas Manual of Uniform Traffic Control Devices for plan review and approval by the OWNER and TXDOT prior to the start of construction. The TXDOT permit for work in the TXDOT ROW is subject to TXDOT approval of the CONTRACTOR's traffic control plan.
- B. Furnish, install and maintain barricades, warning signs and other traffic handling devices of the size and type specified in the Manual of Uniform Traffic Control Devices or as directed by the ENGINEER or highway department official.
- C. Inspect and properly maintain traffic controls each evening and during the weekend in addition to normal daytime working hours. The CONTRACTOR is responsible for all costs associated with installation and maintenance of traffic controls.
- D. Designate one person who will be accessible to the OWNER on a 24-hour basis and will be responsible for the maintenance of the barricades and the work site.
- E. Coordinate any interruption of traffic with TXDOT, the OWNER, Fire and Police Departments, and the ENGINEER at least 24 hours in advance of such interruptions.
- F. Furnish, install, and maintain street barricades on all dead end streets and as necessary during construction to maintain job safety.

1.05 EASEMENTS OF RIGHT-OF-WAY

- A. CONTRACTOR shall confine his construction operations within the limits indicated on the Drawings, and shall use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies so as to cause the least possible damage to property and interference with traffic. If the CONTRACTOR requires additional easement for his operations, the CONTRACTOR is solely responsible for acquisition and maintenance of the easement. No additional compensation will be provided by the OWNER.
- B. Easements
 - 1. Easements across private property are indicated on the Drawings. CONTRACTOR shall set stakes to mark the boundaries of construction easement across private property. The stakes shall be protected and maintained until completion of construction and cleanup.

C. Rights-of-Way

1. Permits for Work in rights-of-way shall be obtained by the CONTRACTOR. All Work performed and all operations of CONTRACTOR, his employees, or subcontractors, within the limits of railroad and highway rights-of-way, shall be in conformity with the requirements and be under the control (through OWNER) of the railroad or highway authority owning, or having jurisdiction over and control of, the right-of-way in each case.

1.06 OPERATION OF EXISTING FACILITIES

- A. Existing water and wastewater facilities shall be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the degree of service provided. Provided permission is obtained from OWNER in advance, portions of the existing facilities may be taken out of service for short periods corresponding with periods of minimum service demands.
- B. CONTRACTOR shall provide temporary facilities and make temporary modifications as necessary to keep the existing facilities in operation during the construction period.

1.07 CONNECTIONS TO EXISTING FACILITIES

- A. Unless otherwise specified or indicated, CONTRACTOR shall make all necessary connections to existing facilities including structures, drain lines, and utilities. In each case, CONTRACTOR shall receive permission from OWNER or the owning utility prior to undertaking connections. CONTRACTOR shall protect facilities against deleterious substances and damage.
- B. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials and labor shall be on hand at the time of undertaken the connection. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

1.08 UNFAVORABLE CONSTRUCTION CONDITIONS

- A. No portion of the Work shall be constructed under conditions which adversely affect the quality or efficiency thereof, unless special means or precautions are taken by CONTRACTOR to perform the Work in a proper and satisfactory manner.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01019
CONTRACT CONSIDERATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Payment Procedures
- B. Change Procedures
- C. Measurement and Payment for Unit Prices
- D. Correlation of CONTRACTOR Submittals

1.02 PAYMENT PROCEDURES

- A. Submit one (1) copy of the Application for Payment based upon Application for Payment, or other proposed format as agreed upon by OWNER in advance of request.
- B. Payment Period: at intervals stipulated in the Agreement.
- C. Submit an updated Progress Schedule and Photographs with each Application for Payment in accordance with Section 01300 - Submittals.
- D. Submit data justifying dollar amounts in question when ENGINEER requires substantiating information.

1.03 CHANGE PROCEDURES

- A. ENGINEER may advise of minor changes in the Work not involving an adjustment to Contract Price or Contract Time as authorized by Paragraph 9.5 of the General Conditions.
- B. ENGINEER may amend or supplement the Contract Documents as authorized by General Conditions by issuing a detailed description of a proposed change with supplementary or revised Drawings and Specifications, including a change in Contract Time related to the change (with a stipulation for any overtime work required) and the period of time during which the requested price will be considered valid. Prepare and submit an estimate within 15 days.
- C. Propose a change by submitting request for change to ENGINEER and describe the proposed change and its full effect on the Work. Describe the reason for the change and the effect on the Contract Price and Contract Time with full documentation (and a statement describing the effect on Work by separate or other contractors). Document any requested substitutions In accordance with the Procurement General Conditions.
- D. Stipulated Price Change Order: based on CONTRACTOR's maximum price quotation or CONTRACTOR's request for a Change Order as approved by ENGINEER.

- E. Unit Price Change Order: for pre-determined unit prices and quantities and executed on a fixed unit price basis. Changes in Contract Price and Contract Time to be computed as specified for Time and Material Change Order.
- F. Time and Material Change Order: based on itemized account and supporting data after completion of change within time limits indicated in the General Conditions. ENGINEER to determine the change allowable in Contract Price and Contract Time as provided in the General Conditions. Maintain detailed records of work done on this basis, provide full information required for evaluation of proposed changes, and substantiate costs for changes in the Work.
- G. Change Order Form: based on Change Order Form, or other proposed format as agreed upon by OWNER in advance of request.

1.04 CORRELATION OF CONTRACTOR SUBMITTALS

- A. Promptly revise Progress Schedules to reflect any change in Contract Time and revise sub-schedules to adjust time for other items of the Work affected by the change.
- B. Promptly enter changes in Project Record Documents.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Measurement and payment criteria applicable to the Work performed under a unit price payment method.
- B. Defect assessment and non-payment for rejected work.

1.02 AUTHORITY

- A. This Section is the authority for measurement methods and definitions of pay items, and supersedes any such direction which may be stated or implied in the Drawings or in individual sections of the technical specifications (Divisions 2 and higher).
- B. Take all measurements and compute quantities. The OWNER will verify measurements and quantities.
- C. Assist by providing necessary equipment, workers, and survey personnel as required.

1.03 UNIT QUANTITIES SPECIFIED

- A. Quantities indicated in the Bid Proposal are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the OWNER determine payment.
- B. If the actual Work requires more or fewer quantities than those quantities indicated, provide the required quantities at the unit sum/prices contracted.

1.04 MEASUREMENT OF QUANTITIES

- A. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.
- B. Measurement by Area: Measured by square dimension using mean length and width or radius.
- C. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.
- D. Stipulated Sum/Price Measurement: Items measured by weight, volume, area,

1.05 PAYMENT

- A. Payment Includes: Full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work, including overhead and profit.
- B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the OWNER multiplied by the unit sum/price for Work which is incorporated in or made necessary by the Work.

1.06 DEFECT ASSESSMENT

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. The individual specification sections may modify these options or may identify a specific formula or percentage sum/price reduction for defective Work.
- C. The authority of the OWNER to assess the defect and identify payment adjustment, is final.

1.07 NON-PAYMENT FOR REJECTED PRODUCTS

- A. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from the transporting vehicle.
 - 4. Products placed beyond the lines and levels of the required Work.
 - 5. Products remaining on hand after completion of the Work.
 - 6. Loading, hauling and disposing of rejected Products.

1.08 STANDARDS FOR COMPUTING PAY ITEMS

- A. See the General Conditions, particularly paragraphs 2.6.3, 2.9, and 14.1, for additional direction regarding use and application of pay items.
- B. The intent of Pay Items is to address all items shown, specified, required, reasonably implied, or otherwise necessary for the completion of the Work indicated in the Contract Documents. No separate payment will be made for costs (including, but not necessarily limited to labor, equipment, materials, or other CONTRACTOR expenses) arising from the completion of the Work which was indicated in the Contract Documents, whether or not a Pay Item expressly includes such costs. Should the Work include costs not expressly included in any Pay Item, CONTRACTOR is presumed to have included such costs in his bid under related pay items.
 - 1. Other Pay Items not specifically listed in the Pay Item Descriptions below, which are for specific work (such as decommissioning or demolition of an existing facility), may be identified in the Bid Form. These items are provided in order to establish a basis for payment upon completion of work including and related to that described for the Pay Item in the Bid Form.
Should the Work include costs not expressly or impliedly included under any Pay Item, CONTRACTOR is presumed to have included such costs in his bid under the Pay Item entitled "ALL OTHER WORK".
- C. Excavation is unclassified, and construction requiring excavation is paid under the appropriate Pay Item value regardless of the character of ground encountered during Construction.
- D. Pay Item Descriptions
 - 1. MOBILIZATION - Lump sum price (which shall not exceed 5% of the Total Base Bid Amount) shall include all work necessary to mobilize, demobilize and remobilize as necessary to perform Work in accordance with the Contract Documents.

2. REMOVE EXISTING PIPE - Price per linear foot of water and/or sewer (gravity or pressure) line removed and disposed of, regardless of size, depth, or material, which follows the same general alignment of proposed pipes. Flow bypass operations to maintain service to connected customers during construction is also included.
3. ABANDON EXISTING PIPE - Price per cubic yard of flowable fill or grout to be placed in existing buried pipes which are to be filled and abandoned in place.
4. (EACH SIZE) PRESSURE PIPE - Price per linear foot of water and/or pressure sewer line regardless of material and depth of installation shall include furnishing, installing, excavating, bedding, backfilling, and testing the pipe and fittings. Also included is the incidental removal and replacement of existing structures (including all occurrences of less than 25 feet of contiguous pipe) which conflict with, but do not follow the same general alignment of proposed pipes. Restoration, including but not limited to replacement of pavement for the width of the trench plus benches on either side of the trench is also included.
5. CONNECT TO EXISTING (EACH SIZE) DRY LINE - Price per each connection shall include all work necessary for locating and making connection to existing inactive pressure line; including fittings and removing abandoned pipe.
6. CONNECT TO EXISTING (EACH SIZE) WET LINE - Price per each connection shall include all work necessary for locating and making connection to existing active pressure line; including fittings and removing abandoned pipe.
7. (EACH SIZE) (EACH TYPE) VALVE - Price per each for buried valves furnished, installed, excavated, bedded, backfilled, and tested, regardless of depth.
8. (EACH SIZE) GRAVITY SEWER AT (EACH DEPTH) - Price per linear foot of gravity sewer line regardless of material shall include furnishing, installing, excavating, bedding, backfilling, and testing the pipe and appurtenances. Depth for payment shall be measured from the finished grade to the invert of the pipe. Connection to existing gravity sewer lines, manholes, and service connections (whether active or inactive), which is necessary for completion and activation of the new sewer, is included. Also included is the incidental removal and replacement of existing structures (including all occurrences of less than 25 feet of contiguous pipe) which conflict with, but do not follow the same general alignment of proposed pipes. Restoration, including but not limited to replacement of pavement for the width of the trench plus benches on either side of the trench is also included.
9. OPEN-CUT SEWER SERVICE LATERALS - Price per each lateral constructed between the sewer main trench excavation and the property line of the customer served, regardless of size, including a new cleanout at the property line, as well as determining location of and making connection to the existing lateral at the property line. Price includes furnishing, installing, excavating, bedding, backfilling, and testing the lateral and appurtenances. Restoration, including but not limited to replacement of pavement for the width of the trench plus benches on either side of the trench is also included.

10. JACKED SEWER SERVICE LATERALS - Price per each lateral constructed between the sewer main trench excavation and the property line of the customer served by jacking methods, regardless of size, including a new cleanout at the property line, as well as determining location of and making connection to the existing lateral at the property line. Price includes furnishing, installing, and testing the lateral and appurtenances, as well as excavating, backfilling, and restoration of entry and exit pit areas.
11. (EACH DIAMETER) MANHOLES AT (EACH DEPTH RANGE) - Price shall be determined per each manhole based on the specified depth range (for example, 0-8 feet, 8-12 feet, etc.). The depth shall be the actual depth from the top to the flow line of the manhole. Price shall include frame and standard or water tight covers. Restoration, including replacement of pavement for the manhole excavation plus benches around the excavation is also included.
12. DROP CONNECTIONS - Price shall be determined per vertical foot for each manhole drop connection constructed regardless of size. Depth for payment shall be measured between the upper and lower inverts of the drop pipe.
13. REMOVE EXISTING MANHOLE - Price per each manhole removed and disposed of, regardless of diameter, depth, or material.
14. ABANDON EXISTING MANHOLE - Price per each manhole abandoned in place, including plugging connected sewer lines, excavating, backfilling, filling manhole, removing upper section(s), and pavement replacement for the extent of the excavation plus benches around the excavation perimeter.
15. JACK & BORE (EACH CASING SIZE) - Price shall be determined per linear foot for furnishing and installing casing pipe by boring or tunneling, furnishing and threading carrier pipe, blocking, sealing ends; excavating, dewatering, and backfilling pits; and all other work that is required to complete the installation.
16. (EACH SIZE) CASING PIPE - OPEN TRENCH - Price shall be determined per linear foot for furnishing and installing casing pipe in an open trench, furnishing and threading carrier pipe, spacers, sealing ends, pits and all other work that is required to complete the installation. Price shall include excavation and backfill.
17. (EACH SIZE) CURE-IN-PLACE PIPING - Price shall be determined per linear foot of pipe, for furnishing, installing, cleaning, and televising cure-in-place piping, and shall include staging and restoration of entry and exit areas. Flow bypass operations to maintain service to connected customers during construction is also included.
18. (EACH EXISTING SIZE X PROPOSED SIZE) PIPE BURSTING - Price shall be determined per linear foot of pipe, for furnishing, installing, and testing pipe burst construction, and shall include staging, excavation, dewatering, backfilling, and restoration of entry and exit areas. Flow bypass operations to maintain service to connected customers during construction is also included.
19. DEWATERING - Price shall be determined per linear foot of pipe installed by open trench methods, where dewatering is deemed necessary by the OWNER's inspector in order to keep the trench dry for pipe installation.
20. TRENCH SAFETY - Price shall be determined per linear foot of trench, where excavation depth exceeds five feet, to include compliance with all applicable OSHA and Texas Health and Safety Code requirements.

21. TRENCH SAFETY PLAN - Lump Sum Price shall include compensation for CONTRACTOR's registered Professional Engineer to design the Trench Safety system, as well as CONTRACTOR's training of employees and other related administration of the Trench Safety Plan.
22. PAVEMENT REPLACEMENT - Price shall be determined per square yard of asphaltic pavement to be replaced outside of utility excavation limits, including removal of existing subgrade, base, and surface, and replacement with new subgrade, base, and surface.
23. PAVEMENT REPAIR - Price shall be determined per square yard of asphaltic pavement to be repaired outside of utility excavation limits, including milling of existing surface, and replacement with new surface.
24. LIFT STATION - Lump Sum Price shall include all work (including, but not limited to civil, mechanical, electrical, structural, start-up, and testing work) within the area of the limits of construction as shown on Drawings as necessary for the complete construction and/or rehabilitation of the lift station, including dewatering, and decommissioning and removal of existing components as called for. Price shall also include associated landscaping and access drive improvements located outside of the proposed fence area or lot, as well as lift station-specific appurtenances (e.g., manhole, flow meter or force main air release valve) and connections located outside of the proposed fence area or lot due to site space limitations.
25. ALL OTHER WORK - Lump Sum Price shall include all work indicated in the Contract Documents (including, but not necessarily limited to labor, equipment, materials, or other CONTRACTOR expenses arising from the completion of the Work) which the CONTRACTOR deems to be expressly and impliedly omitted from, and unrelated to, other Pay Items listed in the Bid Form.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01039
COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Coordination.
- B. Preconstruction Conference.
- C. Site Mobilization Meeting.
- D. Progress Meetings.
- E. Preinstallation Conference.
- F. Field Engineering.

1.02 COORDINATION

- A. Inform OWNER and ENGINEER of the address for sending to which official correspondence and the address and telephone number of CONTRACTOR's representative who will be Project Manager for the Contract and responsible and available outside of normal working hours for emergency repairs and maintenance of safety devices.
- B. During periods of construction and testing keep OWNER and ENGINEER informed in writing with name, address, and telephone number of CONTRACTOR's representative who will be responsible and available outside of normal working hours for emergency repairs and the maintenance of safety devices.
- C. Identify correspondence, drawings, data and materials, packing slips or other items associated with this Contract as that identified on the Cover.
- D. Coordinate scheduling, submittals, and Work for the various Sections of Specifications to effectuate an efficient and orderly sequence for installing interdependent construction elements, with provisions for accommodating items installed later.
- E. Coordinate Work of various Sections with interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.
- F. Coordinate space requirements and installation of mechanical and electrical work, which are indicated by diagram on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, maintenance, and repairs.
- G. In finished areas (except as otherwise indicated), conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

- H. Coordinate completion and clean up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for OWNER's partial occupancy.
- I. After OWNER occupancy of premises, coordinate access to site for correction of defective Work and/or incomplete Work to minimize disruption of OWNER's activities.
- J. Provide coordination in accordance with Article 7 of the General Conditions.

1.03 PRECONSTRUCTION CONFERENCE

- A. OWNER to schedule a preconstruction conference in accordance with General Conditions Article 2.
- B. Agenda:
 - 1. Distribute Contract Documents.
 - 2. Finalize preliminary Progress Schedule, submittal schedule and schedule of values.
 - 3. Designate personnel representing each party.
 - 4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, testing, Change Orders and Contract closeout procedures.
 - 5. Scheduling.

1.04 SITE MOBILIZATION MEETING (RESERVED)

- A. OWNER to schedule a meeting at the Project site before CONTRACTOR occupancy.
- B. Attendance Required: OWNER, *ENGINEER, * *Special Consultants, * CONTRACTOR, *CONTRACTOR's Superintendent, * and major Sub CONTRACTORS.
- C. Agenda:
 - 1. Use of premises by OWNER and CONTRACTOR.
 - 2. OWNER's requirements *and *partial* occupancy*.
 - 3. Construction facilities and controls provided by OWNER.
 - 4. Temporary utilities provided by OWNER.
 - 5. Survey and *building* * * layout.
 - 6. Security and housekeeping procedures.
 - 7. Schedules.
 - 8. Procedures for testing.
 - 9. Procedures for maintaining record documents.
 - 10. Requirements for start-up of equipment.
 - 11. Inspection and acceptance of equipment put into service during construction period.

1.05 PROGRESS MEETINGS

- A. OWNER to schedule a progress meeting no later than 60 days after the Preconstruction Conference and a monthly meeting throughout progress of the Work. Make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- B. Attendance: CONTRACTOR, major Subcontractors, OWNER, and ENGINEER, as appropriate to agenda topics for each meeting.
- C. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Unresolved issues.
 - 3. Review Work progress.
 - 4. Observations, problems, and decisions.
 - 5. Identification of problems that impede planned progress.
 - 6. Review of submittals schedule and status of submittals.
 - 7. Review of off-site fabrication and delivery schedules.
 - 8. Maintenance of progress schedule.
 - 9. Corrective measures to regain projected schedules.
 - 10. Planned progress during succeeding Work period.
 - 11. Coordination of projected progress.
 - 12. Maintenance of quality and work standards.
 - 13. . Effect of proposed changes on progress schedule and coordination.
 - 14. Other business relating to Work.

1.06 PREINSTALLATION CONFERENCE

- A. When required in individual Specification Section, convene a preinstallation conference at work site before commencing Work of the Section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific Section. Notify ENGINEER 5 days in advance of meeting date.
- C. Make arrangements for meeting and preside at conference.
- D. Review conditions of installation, preparation and installation procedures, and coordination with related work.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 FIELD ENGINEERING

- A. Surveying: All surveying shall be performed by a Land Surveyor registered in the State of Texas.
 - 1. Existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other utilities and construction. Use "One-Call," 1-800-DIG-TESS or (800) 344-8377.

2. Furnish all surveys necessary to perform the Work. Maintain surveyor's log of control and other survey work. Keep log available for reference.
3. Verify layout information shown on the Drawings in relation to existing benchmarks before laying out of the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
4. Promptly report lost or destroyed reference points, benchmarks, or control points. Promptly report requirements relocate reference and control points due to changes in grades. Promptly replace lost or destroyed control points based on the original survey control points.

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Submittal procedures for:
1. Schedule of Values.
 2. Construction Schedules.
 3. Shop Drawings, Product Data, and Samples
 4. Operations and Maintenance Data.
 5. Manufacturer's Certificates.
 6. Construction Photographs.
 7. Project Record Documents.
 8. Video Tapes.
 9. Design Mixes.

1.02 SUBMITTAL PROCEDURES

- A. Scheduling and Handling:
1. Schedule submittals well in advance of the need for the material or equipment for construction. Allow time to make delivery of material or equipment after submittal has been approved.
 2. Develop a submittal schedule that allows sufficient time for initial review, correction, resubmission and final review of all submittals. The Engineer will review and return submittals to the Contractor as expeditiously as possible but the amount of time required for review will vary depending on the complexity and quantity of data submitted. In no case will a submittal schedule be acceptable which allows less than 30 days for initial review by the Engineer. This time for review shall in no way be justification for delays or additional compensation to the Contractor. Recognizing that time is of the essence, the Contractor is to stamp the top of each submittal with the words ROUTINE or CRITICAL. Routine submittals shall be processed in accordance with the timeframe set forth previously. Critical submittals are those that: were overlooked by the Contractor, involve complex coordination, or are crucial to the successful completion of a specific portion of the project. For critical submittals:
 - a. Contractor shall indicate on the submittal his realistically estimated date of when a review must be returned;
 - b. Upon return of critical submittals, Contractor shall date-stamp the transmittal page with date and time received;
 - c. Contractor is cautioned that the use of critical submittals is not a substitute for proper due diligence on his part. Review of critical submittals found to be routine shall be accompanied by an invoice for excess time and material expenditures that were required in order to complete the critical review as compared to a routine review. The Resident Project Representative shall

make the determination as to whether a critical submittal was in fact routine.

3. The Engineer's review of submittals covers only general conformity to the Drawings, Specifications and dimensions which affect the layout. The Contractor is responsible for quantity determination. Quantities may be verified by the Engineer. The Contractor is responsible for any errors, omissions or deviations from the Contract requirements; review of submittals in no way relieves the Contractor from his obligation to furnish required items according to the Drawings and Specifications.
4. Submit sufficient copies of documents. Unless otherwise specified in the following paragraphs or in the Specifications, provide 3 copies in addition to the number the Contractor requires returned. For portions of the project involving electrical or signal components, provide one additional copy (4 copies in addition to the number the Contractor requires returned).
5. Revise and resubmit submittals as required. Identify all changes made since previous submittal.
6. A maximum of three (3) reviews will be conducted on any one submittal. Submittals requiring more than three (3) reviews will be considered inadequate and result in a recovery of review expenses from the Contractor.
7. The Contractor shall assume the risk for material or equipment which is fabricated or delivered prior to approval. No material or equipment shall be incorporated into the Work or included in periodic progress payments until approval has been obtained in the specified manner.

B. Transmittal Form and Numbering:

1. Transmit each submittal to the Engineer with a Transmittal Cover.
2. Sequentially number each transmittal including the Specification Section number followed by a area designation number and the sequential number beginning with the number 1. Re-submittals shall use the original number with an alphabetic suffix (i.e., 2A for first re-submittal of Submittal 2 or 15C for third re-submittal of Submittal 15). Each submittal shall only contain one type of work, material, or equipment. Mixed submittals will not be accepted.
3. Identify time nature of submittal, either ROUTINE or CRITICAL.
4. Identify variations from requirements of Contract Documents and identify product or system limitations.
5. For submittal numbering of video tapes, see paragraph 1.10 Video.

C. Transmittal Cover:

1. Transmittal Cover, certifying that the items have been reviewed in detail and are correct and in accordance with Contract Documents, except as noted by any requested variance. A stamp may be used to print the information on the Transmittal Cover except for the Contractor's signature. Regardless of whether the transmittal cover is typed or stamped, the transmittal cover text shall be a minimum of fourteen (14) point.
2. As a minimum, Transmittal Cover information shall include:
 - a. Contractor's name.
 - b. Job number.
 - c. Submittal number.

- d. Certification statement that the Contractor has reviewed the submittal and it is in compliance with the Contract Documents.
 - e. Signature line for Contractor.
 - f. Submittal type – routine or critical
3. The bottom half of the Transmittal Cover shall be kept blank.

D. Electronic copy submittals:

1. Electronic copies of the approved paper copy Operation and Maintenance Manuals are to be produced in Adobe Acrobat's Portable Document Format (PDF) Version 9.0 or higher.
2. Do not password protect and/or lock the PDF document.
3. Create one (1) PDF document (PDF file) for each equipment O&M Manual.
4. Drawings or other graphics must be converted to PDF format and made part of the one (1) PDF document.
 - a. Scanning to be used only where actual file conversion is not possible.
5. Rotate pages that must be viewed in landscape to the appropriate position for easy reading.
6. Images only shall be scanned at a resolution of 300 dpi or greater.
 - a. Perform Optical Character Recognition (OCR) capture on all images.
 - b. Achieve OCR with the "original image with hidden text" option.
 - c. Word searches of the PDF document must operate successfully to demonstrate OCR compliance.
7. Create bookmarks in the navigation frame, for each entry in the Table of Contents/Index.
 - a. Normally three (3) levels deep (i.e., "Chapter," "Section," "Sub-section").
8. Thumbnails must be generated for each PDF file.
9. Set the opening view for PDF files as follows:
 - a. Initial view: Bookmarks and Page.
 - b. Magnification: Fit in Window.
 - c. Page layout: Single page.
 - d. Set the file to open to the cover page of the manual with bookmarks to the left, and the first bookmark linked to the cover page.
 - e. All PDF documents shall be set with the option "Fast Web View" 1 to open the first 2 pages of the document for the viewer while the rest of the document continues to load.
 - f. File naming conventions:
 - 1) File names shall use a "ten dot three" convention (XXXXXX-YYYY-Z.PDF) where XXXXX is the Specification Section number, YYYY is the area designation number and Z is the sequential submittal number.
10. Labeling:
 - a. As a minimum, include the following labeling on all CD-ROM discs and jewel 19 cases:
 - 1) Project Name.
 - 2) Equipment Name and Project Tag Number.
 - 3) Project Specification Section.
 - 4) Manufacturer Name.
 - 5) Vendor Name.

11. Binding:

- a. Include labeled CD(s) in labeled jewel case(s). Bind jewel cases in standard three-ring binder Jewel Case Page(s), inserted at the front of the Final paper copy submittal.
- b. Jewel Case Page(s) to have means for securing Jewel Case(s) to prevent loss (e.g., flap and strap).

1.03 CONSTRUCTION SCHEDULE

- A. Submit Construction Schedules in accordance with Section 01325 – Construction Schedule.

1.04 OPERATIONS AND MAINTENANCE DATA

- A. Submit Operations and Maintenance data in accordance with Section 01782 - Operations and Maintenance Data.

1.05 MANUFACTURER'S CERTIFICATES

- A. When required in Specification sections, submit manufacturers' certificate of compliance for review by Engineer.
- B. Transmittal Cover, as described in paragraph 1.02C, shall be placed on front page of the certification.
- C. Submit supporting reference data, affidavits, and certifications as appropriate.
- D. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

1.06 CONSTRUCTION PHOTOGRAPHS

- A. Submit Construction Photographs in accordance with Section 01321 – Construction Photographs.

1.07 PROJECT RECORD DOCUMENTS

- A. Submit Project Record Documents in accordance with Section 01785 - Project Record Documents.

1.08 VIDEO

- A. Submit television video tapes as required for Acceptance Testing for Sanitary Sewers.
- B. Transmittal forms for video tapes shall be numbered sequentially beginning with TV01, TV02, etc.

1.09 DESIGN MIXES

- A. When specified in Specifications, submit design mixes for review.
- B. Transmittal Cover, as described in paragraph 1.02C, shall be placed on front page of each design mix.
- C. Mark each design mix to identify proportions, gradations, and additives for each class and type of design mix submitted. Include applicable test results on samples for each mix.

D. Maintain a copy of approved design mixes at mixing plant.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL

- A. Submittals made as part of this project will become a vital portion of the project record and will be referenced by the Owner for the useful life of the project. All submittals shall be of high quality. To this end, the following requirements are made:
1. As much as possible, all catalog cuts and manufacturer's information shall be original.
 2. Copies, when required, shall be clean and entirely legible.
 3. Neither facsimiles nor copies of facsimiles are to be included as part of any submittal.
 4. Binders, if used, shall be rugged, lock-ring type. Spine of binders shall be clearly labeled with the information outlined in items 1.02 C.2.a. through c.
- B. Reviewed submittals shall be returned to Contractor for distribution to subcontractors and other trades as required. As a minimum, submittals returned to the Contractor will be marked with review comments indicating findings of the review and giving instruction as to necessity of a re-submittal. The Engineer may, at his option, use a stamp for this purpose. Detailed correspondence covering the review may also accompany returned submittals.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SUBMITTALS

01300 - 6

SECTION 01325
CONSTRUCTION SCHEDULE

PART 1 - PART 1 GENERAL

1.01 GENERAL

- A. Provide Construction Schedules for Work included in this Contract in accordance with requirements in this Section. Create a Construction Schedule using Critical Path Method (CPM) computer software capable of mathematical analysis of Precedence Diagramming Method (PDM) schedules. Provide printed activity listings and bar charts in formats described in this Section.
- B. Combine activity listings and bar charts with a narrative report to form the Contractor's Construction Schedule submittal for the Engineer.

1.02 SCHEDULING STAFF

- A. Employ or retain services of an individual experienced in critical path scheduling for the duration of the Contract. This person shall cooperate with the Engineer and shall update the Contractor's schedule at least monthly as required to indicate current status of the Work.

1.03 SUBMITTALS

- A. Make Construction Schedule submittals for review by the Engineer in accordance with requirements of the Conditions of the Contract.
- B. During the pre-construction meeting provide sample bar charts and activity listings produced from the scheduling software proposed. Scheduling software is subject to approval of the Engineer and must meet requirements provided in this Section. Review of the samples will be provided by the Engineer within 7 days of the submittal.
- C. Within 21 days of receipt of approval of the Contractor's format, or 30 days of the Notice to Proceed, whichever is later, submit a proposed Construction Schedule for review. The Construction Schedule submittal shall be based on the following:
 - 1. The level of detail and number of activities required in the schedule are dependent on the project type.
 - a. For wastewater projects, the work shall be categorized by Work Type and Area Code in the schedule.
 - 2. For projects with multiple types of tasks within the scope, these types of work shall be indicated separately within the schedule.
 - 3. For projects with work at different physical locations or service areas, or different facilities within a site, each location or facility shall be indicated separately within the schedule. Work on each floor of a multi-story building shall be shown as separate tasks.
 - 4. For projects with multiple crafts or significant subcontractor components, these elements shall be indicated separately within the schedule. Unless permitted by the Engineer, tasks shall consist of work covered by only one

division of the Project Manual.

5. Unless permitted by the Engineer, each schedule task shall be the same as a schedule of values line item, and vice versa.
 6. For projects with significant major equipment items or materials representing over 5 percent of the Total Contract Price, the schedule shall indicate dates when these items are to be purchased, when they are to be delivered, and when installed. Activities for testing, adjustment, and delivering O & M manuals shall be included.
 7. No task except the acquisition of major equipment items shall represent more than one percent of the Total Contract Price for facility projects and 3 percent of the Total Contract Price for other projects. The duration of tasks may not exceed 40 calendar days.
 8. For projects where operating facilities are involved, each period of work which will impact any process or operation shall be identified in the schedule and must be agreed to by the Engineer and the facility operator prior to starting work in the area.
 9. Construction Schedule submittals shall include:
 - a. Printed bar charts which meet the criteria outlined in this Section and which are produced by the Contractor's approved scheduling software.
 - b. Activity listings which meet the criteria outlined in this Section and which are produced by the Contractor's approved scheduling software.
 - c. Predecessor/successor listing sorted by Activity ID which meets the criteria outlined in this Section and which is produced by the Contractor's approved scheduling software.
 - d. A logic network diagram shall be required with the first construction schedule submittal for facilities projects.
 - e. A graphic or tabular display of estimated monthly billings for the Work shall be prepared and submitted by the Contractor with the first schedule submittal. This information is not required in monthly updates, unless significant changes in work require re-submittal of the schedule for review. The display shall allocate units indicated in the bid schedule or the schedule of values to Construction Schedule activities. (Weighted allocations are acceptable, where appropriate). The dollar value associated with each allocated unit will be spread across the duration of the activity on a monthly basis. The total for each month and a cumulative total will be indicated. These monthly forecasts are only for planning purposes of the Engineer. Monthly payments for actual work completed will be made by the Engineer in accordance with the Conditions of the Contract.
 - f. A narrative report which shall provide the information outlined in this Section.
- D. No payment will be made until the Construction Schedule and billing forecast are accepted by the Engineer.

- E. If the Contractor desires to make changes in his method of operating and scheduling, after approval of the original schedule has been given by the Engineer, the Contractor shall notify the Engineer in writing, stating the reasons for the change. If the Engineer considers these changes to be of significant nature, the Contractor may be required to revise and resubmit for approval all or the affected portion of the Contractor's Construction Schedule to show the effect on the Work.
- F. Upon written request from the Engineer, the Contractor shall revise and submit for approval all or any part of the Construction Schedule submittal to reflect changed conditions in the Work or deviations made from the original plan and schedule.
- G. The Contractor's Construction Schedule shall thereafter be updated with Actual Start and Actual Finish Dates, Percent Complete, and Remaining Duration of each Activity and submitted monthly. The data date to be used in updating the monthly Construction Schedule shall be the same data date as is used in the monthly Application for Payment. This monthly update of the schedule shall be required before the monthly Application for Payment will be processed for payment.

1.04 SCHEDULING COMPUTER SOFTWARE REQUIREMENTS

- A. The Contractor's Construction Schedule shall be created using CPM computer software which provides mathematical analysis of PDM schedules. The software shall be capable of creating bar charts and activity listings which can be sorted by various fields, i.e., Sort by Activity ID; Sort by Early Start; Sort by Total Float; Sort by Area Code; sort by specification section number; and sort by Subcontractor. The software shall be capable of producing a logic network diagram.
- B. The PDM scheduling software shall be capable of producing activity listings and bar charts with the following information for each activity in the schedule:
 - 1. Activity ID
 - 2. Activity Description
 - 3. Estimated (Original) Duration
 - 4. Remaining Duration
 - 5. Actual Duration
 - 6. Early Start Date
 - 7. Late Start Date
 - 8. Early Finish Date
 - 9. Late Finish Date
 - 10. Free Float
 - 11. Total Float
 - 12. Activity Codes (such as Area Code, Work Type, Specification Section, Subcontractor)
- C. The PDM scheduling software shall be capable of printing calendars using the mathematical analysis of the schedule, indicating the Contractor's standard work days of the week and scheduled holidays.

- D. Scheduling software shall be capable of printing an activity listing which indicates the Predecessors and Successors, Lag Factors and Lag Relationships used in creating the logic of the schedule.
- E. Scheduling software shall be capable of printing a bar chart of the entire schedule for the Work included in this Contract. The bar chart format shall provide a monthly time scale and shall be such that a 12-month time scale shall not exceed one page width. Bar charts may be printed or plotted on 8.5" x 11", 8.5" x 14" or 11" x 17" sheet sizes. Over-size plots are not acceptable.

1.05 NARRATIVE SCHEDULE REPORT

- A. The Narrative Report shall include a listing of the Activities Started This Month; Activities Completed This Month; Activities Continued This Month; Activities Scheduled to Start or Complete Next Month; Problems Encountered This Month; Actions Taken to Solve These Problems.
- B. The narrative Schedule Report shall include a description of changes made to the Construction Schedule Logic (i.e., changes in Predecessors and Lags); Activities Added to the Schedule; Activities Deleted from the Schedule; any other changes made to the Schedule other than the addition of Actual Start Dates and Actual Finish Dates and changes of Data Date and Remaining Durations for recalculation of mathematical analysis.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01500
TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and General provisions of Contract, including General Conditions and Supplementary General Conditions, and Division 1 requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 OFFICE AT THE WORK SITE

- A. During the performance of this Contract, CONTRACTOR shall maintain a suitable office at or near the site of the Work which shall be the headquarters of his superintendent. Any communication given to the superintendent or delivered to CONTRACTOR's office at the site of the Work in his absence shall be deemed to have been delivered to CONTRACTOR.
- B. In addition, CONTRACTOR shall provide a suitable field office with at least 200 square feet of floor space, either adjacent to, or partitioned off from, his office at the site for use by OWNER's Representative. The office shall be provided with outside entrance door with a substantial lock, glazed windows suitable for light and ventilation, and adequate heating, air conditioning, and lighting facilities. CONTRACTOR shall pay all electricity and heating bills and shall provide telephone services with a telephone as specified hereinafter. The office shall be furnished with a desk, two four-drawer filing cabinets, a table, two chairs, a plan rack, and a locker for storage of surveying instruments. The doors on the locker shall be equipped for padlocking. The general arrangement of the office and facilities provided shall be acceptable to OWNER's Representative.

3.02 WATER FOR CONSTRUCTION

- A. All water required for and in connection with the Work to be performed shall be furnished by and at the expense of the CONTRACTOR through meters installed on hydrants. CONTRACTOR shall supply all necessary tools, hose and pipe, and shall make necessary arrangements for securing and transporting such water and shall take water in such a manner, and at such times, that will not produce a harmful drain or decrease of pressure in the OWNER's water system. It shall be the CONTRACTOR's responsibility to make arrangements with the BPUB for the metering and reporting of the amount of water used. Water shall not be used in a wasteful manner. Standard hydrant wrenches shall be used for opening and closing of fire hydrants. In no case shall pipe wrenches be used for this purpose. Temporary lines shall be removed when no longer required.

3.03 TELEPHONE SERVICE

- A. CONTRACTOR shall make all necessary arrangements and pay all installation charges for telephone lines in his offices at the site and shall provide all telephone instruments.

3.04 SANITARY FACILITIES

- A. CONTRACTOR shall furnish temporary sanitary facilities at the site, as provided herein, for the needs of all construction workers and others performing Work or furnishing services on the Project.
- B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. If toilets of the chemically treated type are used, at least one toilet shall be furnished for each 20 employees. CONTRACTOR shall enforce the use of such sanitary facilities by all personnel at the site.

3.05 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

- A. CONTRACTOR shall protect, shore, brace, support and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by the CONTRACTOR's operations. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all sod and shrubs in yards, parkways, and medians, shall be restored to their original condition, whether within or outside the easement/right-of way. All replacements shall be made with new materials.
- B. CONTRACTOR shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work, whether by him or his Subcontractors. CONTRACTOR shall make satisfactory and acceptable arrangements with the OWNER of, or the agency having jurisdiction over, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.
- C. All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

3.06 TREE AND PLANT PROTECTION

- A. All trees and other vegetation which must be removed to perform the Work shall be removed and disposed of by the CONTRACTOR; however, no trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed shall be protected against injury from construction operations.
- B. No tree shall be removed outside of permanent easement(s), except where authorized by the ENGINEER. Whenever practicable, CONTRACTOR shall tunnel beneath trees in yards and parking lots when on or near the line of trenching operations. Hand excavations shall be employed as necessary to prevent injury to trees. Care shall be taken with exposed roots, unearthed during construction, so that roots do not dehydrate causing tree damage.
- C. Trees considered by the ENGINEER to have any significant effect on construction operations are indicated on the Drawings and those which are to be preserved are so indicated.
- D. CONTRACTOR shall take extra measures to protect trees designated to be preserved, using methods shown on the Drawings.

3.07 SECURITY

- A. Security shall be in accordance with Section 01540 - Security.
- B. CONTRACTOR shall be responsible for protection of the site, and all Work, materials, equipment, and existing facilities hereon, against vandals and other unauthorized persons.
- C. No claim shall be made against OWNER by reason of any act of an employee or trespasser, and CONTRACTOR shall make good all damage to the OWNER's property resulting from CONTRACTOR's failure to provide security measures as specified.
- D. Security measures shall be at least equal to those usually provided by OWNER to protect existing facilities during normal operations, and shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the site. When required, the CONTRACTOR shall provide a security plan to the OWNER for review as to appropriateness of the security measures proposed.

3.08 ACCESS ROADS

- A. CONTRACTOR shall establish and maintain temporary access roads to various parts of the site as required to complete the Project. Such roads shall be available for the use of all others performing Work or furnishing services in connection with the Project.

3.09 PARKING

- A. CONTRACTOR shall provide and maintain suitable parking areas for the use of all construction workers and others performing Work or furnishing services in connection with the Project, as required, to avoid any need for parking personal vehicles where they may interfere with public traffic, the OWNER's operations, or construction activities.

3.10 DUST CONTROL

- A. Dust Control during construction of this Project shall be performed daily, as directed by the OWNER's representative. No direct payment will be made for dust control. Dust Control shall be considered subsidiary work relating to various Bid items of the Contract.

3.11 TEMPORARY DRAINAGE PROVISIONS

- A. CONTRACTOR shall be responsible for providing for the drainage of storm water and such water as may be applied or discharged on the site in performance of the Work. CONTRACTOR shall obtain ENGINEER approval for temporary drainage facilities which will handle, carry through, or divert around his Work all drainage flow, including storm flow and flows created by construction activity, to prevent silting of waterways or flooding damage to the property and adjacent property.

3.12 EROSION CONTROL

- A. CONTRACTOR shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations which will disturb the natural protection.
- B. CONTRACTOR shall use controls developed from successful techniques elsewhere as approved by ENGINEER. Siltation and/or sedimentation controls shall include dams, berms, and dikes.

3.13 POLLUTION CONTROL

- A. CONTRACTOR shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris and the substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse. No sediment, debris or other substance will be permitted to enter sanitary sewers and reasonable measures shall be taken by CONTRACTOR to prevent such materials from entering any drain or watercourse.
- B. CONTRACTOR shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
- C. CONTRACTOR is specifically cautioned that disposal of materials into any water of the State must conform to the requirements of the Texas Commission on Environmental Quality (TCEQ), and any applicable permit from the U.S. Army Corps of Engineers.

3.14 NOISE CONTROL

- A. CONTRACTOR shall comply with the applicable Noise Ordinances. CONTRACTOR shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound level in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

3.15 FENCES

- A. All existing fences affected by the Work shall be maintained by the CONTRACTOR until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the OWNER of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across any construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.
- B. Upon completion of the Work across any tract of land, CONTRACTOR shall restore all fences to preconstruction, or to a better, condition and to their preconstruction location.

3.16 MAIL BOXES

- A. CONTRACTOR shall remove, reset temporarily, and relocate permanently all mail boxes that are within construction site limits conforming to requirements of United States Postal Service. Mailboxes shall not be laid on the ground, but shall be temporarily reset the same day as removed. Payment for removing and resetting of mail boxes will not be paid for directly, but will be considered subsidiary to the various Bid items. Any damage to mail boxes or posts shall be the responsibility of the CONTRACTOR.

3.17 EMERGENCY FACILITIES

- A. Free access shall be maintained at all times to fire lanes and emergency and utility control facilities such as fire hydrants, fire alarm boxes, police call boxes, and utility valves, manholes, junction boxes, etc. In the event that it is necessary to make one of these facilities temporarily inaccessible, CONTRACTOR shall obtain approval of such action,

and schedule, of Work from the OWNER. CONTRACTOR shall also provide at least 24 hours prior notice to the Fire Department, Police Department, and City Department governing the affected utility. The same Department(s) shall be promptly notified by the CONTRACTOR when such facilities are placed back in unobstructed service.

END OF SECTION

TEMPORARY FACILITIES

01500 - 5

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01576
WASTE MATERIAL DISPOSAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Disposal of waste material and salvageable material.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for waste material disposal under this Section. Include payment in unit price for related sections.

1.03 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.
- B. Obtain and submit disposal permits for proposed disposal sites if required by federal, state and local ordinances.
- C. Submit a copy of written permission from property owner, along with description of property, prior to disposal of excess material.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.01 SALVAGEABLE MATERIAL

- A. Excavated Material: When indicated on Drawings, load, haul, and deposit excavated material at a location or locations shown on Drawings outside the limits of Project.
- B. Other Salvageable Materials: Conform to requirements of individual Specification Sections.

3.02 EXCESS MATERIAL

- A. Vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage, shall become the property of Contractor and shall be removed from the job site and legally disposed of.
- B. Waste materials shall be removed from the site on a daily basis, such that the site is maintained in a neat and orderly condition.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01610
BASIC PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Requirements for transportation, delivery, handling, and storage of materials and equipment.

1.02 PRODUCTS

- A. Products: Means material, equipment, or systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. Do not reuse materials and equipment, designated to be removed, except as specified by the Contract Documents.
- C. Provide equipment and components from the fewest number of manufacturers as is practical, in order to simplify spare parts inventory and to allow for maximum interchangeability of components. For multiple components of the same size, type or application, use the same make and model of component throughout the project.

1.03 TRANSPORTATION

- A. Make arrangements for transportation, delivery, and handling of equipment and materials required for timely completion of the Work.
- B. Transport and handle products in accordance with instructions.
- C. Consign and address shipping documents to the proper party giving name of Project and street address. Shipments shall be delivered to the Contractor.

1.04 DELIVERY

- A. Arrange deliveries of products to accommodate the short term site completion schedules and in ample time to facilitate inspection prior to installation. Avoid deliveries that cause unnecessarily lengthy use of limited storage space.
- B. Coordinate deliveries to avoid conflict with Work and conditions at the site and to accommodate the following:
 - 1. Work of other contractors or the Owner.
 - 2. Limitations of storage space.
 - 3. Availability of equipment and personnel for handling products.
 - 4. Owner's use of premises.
- C. Have products delivered to the site in manufacturer's original, unopened, labeled containers.
- D. Immediately upon delivery, inspect shipment to assure:
 - 1. Product complies with requirements of Contract Documents.
 - 2. Quantities are correct.

3. Containers and packages are intact; labels are legible.
4. Products are properly protected and undamaged.

1.05 PRODUCT HANDLING

- A. Coordinate the off-loading of materials and equipment delivered to the job site. If necessary to move stored materials and equipment during construction, Contractor shall relocate materials and equipment at no additional cost to the Owner.
- B. Provide equipment and personnel necessary to handle products, including those provided by the Owner, by methods to prevent damage to products or packaging.
- C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging products or surrounding areas.
- D. Handle products by methods to prevent over bending or overstressing.
- E. Lift heavy components only at designated lifting points.
- F. Handle materials and equipment in accordance with Manufacturer's recommendations.
- G. Do not drop, roll, or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.06 STORAGE OF MATERIAL

- A. Store and protect materials in accordance with manufacturer's recommendations and requirements of these Specifications.
- B. Make necessary provisions for safe storage of materials and equipment. Place loose soil materials, and materials to be incorporated into the Work to prevent damage to any part of the Work or existing facilities and to maintain free access at all times to all parts of the Work and to utility service company installations in the vicinity of the Work. Keep materials and equipment neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants. Arrange storage in a manner to provide easy access for inspection.
- C. Restrict storage to areas available on the construction site for storage of material and equipment as shown on Drawings or approved by the Resident Project Representative.
- D. Provide off-site storage and protection when on-site storage is not adequate.
- E. Do not use lawns, grass plots, or other private property for storage purposes without written permission of the owner and other person in possession or control of such premises.
- F. Protect stored materials and equipment against loss or damage.
- G. Store in manufacturers' unopened containers.
- H. Materials delivered and stored along the line of the Work shall be neatly, safely, and compactly stacked along the work site in such manner as to cause the least inconvenience and damage to property owners and the general public, and shall be not closer than 3 feet to any fire hydrant. Public and private drives and street crossings shall be kept open.

- I. Damage to lawns, sidewalks, streets or other improvements shall be repaired or replaced to the satisfaction of the Resident Project Representative. The total length which materials may be distributed along the route of construction at any one time is 1000 lineal feet, unless otherwise approved in writing by the Resident Project Representative.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01700
PROJECT CLOSEOUT PROCEDURE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK AND RELATED DOCUMENTS

- A. Furnish all work and materials, appliances, tools, equipment, facilities, transportation and services required and incidental thereto, as shown on drawings and/or specified herein including but not limited to; the submittal of closeout documents, final cleaning of materials and equipment and furnishing permit clearances, guarantees and warranties.
- B. Related Work Specified Elsewhere:
 - 1. Submittal Requirements: Section 01300
- C. The completion of the closeout procedures indicated in these specifications will be a condition for releasing final payment.

1.02 PROJECT CLEAN-UP

- A. Provide all required personnel, equipment and materials needed to maintain the specified standard of cleanliness. Use only materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material, or as approved by the Engineer/Architect.
- B. Final cleaning shall mean a level of cleanliness generally provided by skilled cleaners using commercial quality, site maintenance equipment and materials.
- C. The Contractor shall schedule a final cleaning as approved by the Engineer/Architect.
- D. The contractor shall restore any disturbed areas or structures to pre-construction conditions or improved conditions.

1.03 ONSITE TRAINING

- A. The Contractor shall provide a demonstration of the operation techniques and methods of the mechanical, electrical and plumbing systems. This demonstration must be coordinated with the Engineer/Architect. The operation and maintenance manuals must be available for use during this training period. Training shall be a minimum of eight (8) hours long.
- B. The Contractor shall propose a time in writing to the Engineer/Architect allowing at least seventy-two (72) hours notice.

1.04 AS BUILT DRAWINGS

- A. Final "As-Built" drawings shall be prepared by the Contractor in accordance with Section 01785 Project Record Documents. These drawings shall indicate all changes or deviations from the construction documents. These drawings shall be submitted as a hard copy and electronic PDF format to the Engineer/Architect on a CD. The drawings must clearly state AS BUILT and be neatly organized.

- B. Copies of “As-Built” wiring diagrams shall be laminated and placed inside each Lift Station’s control panel

1.05 GUARANTEES AND WARRANTIES

- A. The Contractor shall provide a construction warranty letter.
- B. The Contractor shall provide final clearances from all permitting agencies.

1.06 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual Specification sections.
- B. Deliver to location within the Owner’s jurisdiction as directed by the Engineer; obtain receipt prior to final Application for Payment.

1.07 FINAL COMPLETION

- A. The Contractor shall supply a written request for a Final Completion inspection. This request shall include the following:
 1. Certification that the work and actions specified in the Contract Documents has been completed and that the Owner has full use of the site.
 2. All equipment has been tested and balanced and is fully functional.
 3. The Onsite Training Program has been completed and there are no outstanding issues resulting from said program.
 4. A copy of the list of deficiencies generated by the Substantial Completion Inspection, with each item initialed and showing date completed.
 5. A list of all Subcontractors and material suppliers with name, address and phone number. Include source for parts replacement and local representative if different.
 6. Submit all test/adjust/balance records and start-up performance reports.
 7. Submit all tools, keys and any special devices to assure complete operation by the Owner.
 8. Final application for payment.
 9. Waivers, Sworn Statements and Affidavits of Payments to Subcontractors and Suppliers.

END OF SECTION

SECTION 01713
MOBILIZATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Organization and mobilization of the Contractor's forces.
- B. Transporting construction plant and equipment to the jobsite and setting up of same.
- C. Transporting various tools, materials, and equipment to the jobsite.
- D. Erection of temporary buildings and facilities as required for field offices, staging, storage, and

1.02 MEASUREMENT AND PAYMENT

- A. Measurement and payment for mobilization is on a stipulated price basis.
- B. Payment: Mobilization will be paid for at the Contract lump sum price, and will include accumulating tools, apparatus, equipment, materials which are not intended to be incorporated in the Work, and personnel, and performing final removal and demobilization. The Contract lump sum price will be paid as follows:
 - 1. 45 percent of the Contract lump sum price will be made upon receipt and approval by the Engineer of the following items (as applicable):
 - a. Schedule of Values
 - b. Trench Protection Plan
 - c. Construction Schedule
 - d. Establishment of Field Office
 - e. Dewatering Plan
 - 2. 45 percent of the Contract lump sum price will be made upon completion of the Work amounting to five percent of Original Contract Price. The amount of Contract Price designated for mobilization may not be applied in the computing of the five percent of the Original Contract Price.
 - 3. 10 percent of the Contract lump sum price after the Engineer has determined that the Contractor has left the work site in a clean condition after the completion of all phases of work.
- C. Mobilization payments will be subject to retainage amounts stipulated in the General Conditions.
- D. All cost difference between the stipulated amount and the actual cost of the initial mobilization and the cost of all subsequent mobilization shall be included in the various other prices bid.

1.03 DESCRIPTION

- A. Mobilization shall include mobilization of all construction equipment, materials, supplies, appurtenances, facilities, and the like which are not intended to be incorporated in the Work, staffed and ready for commencing and prosecuting the Work; and the subsequent demobilization and removal from the jobsite of said equipment,

appurtenances, facilities, and the like upon completion of the Work.

- B. Mobilization shall also include assembly and delivery to the jobsite of plant, equipment, tools, materials, and supplies necessary for the prosecution of work which are not intended to be incorporated in the Work; the clearing of and preparation of the Contractor's work area; the complete assembly, in working order, of equipment necessary to perform the required work; personnel services preparatory to commencing actual work; and all other preparatory work required to permit commencement of the actual work on construction items for which payment is provided under the Contract.

1.04 SUBMITTALS

- A. Refer to Section 01300-Submittals, for the submittal requirements and procedures.
- B. Submit a plan of the proposed layout of the construction site, including fences, roads, parking, buildings, staging, and storage areas, within seven days after the effective date of the Notice to Proceed.

1.05 DELIVERY

- A. Delivery to the jobsite of construction tools, equipment, plant, temporary buildings, materials, and supplies shall be accomplished in conformance with local governing ordinances and regulations.

1.06 TOOLS AND SUPPLIES

- A. Provide construction tools, equipment, materials, and supplies of the types and quantities necessary to facilitate the timely execution of the Work.
- B. Provide personnel, products, construction materials, equipment, tools, and supplies at the jobsite at the time they are scheduled to be installed or utilized.

1.07 DEMOBILIZATION

- A. Upon completion of the Work, remove construction tools, apparatus, equipment mobile units and buildings, unused materials and supplies, plant, and personnel from the jobsite.
- B. Restore all areas utilized for mobilization to their original, natural state or, when called for in the Contract Documents, complete such areas indicated.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 01725
FIELD SURVEYING

PART 1 - GENERAL

1.01 QUALITY CONTROL

- A. Conform to State of Texas laws for surveys requiring licensed surveyors.

1.02 UNIT PRICES

- A. No separate payment will be made for Field Surveying. Include the cost of Field Surveying in other related bid items.

1.03 SUBMITTALS

- A. Submit to Engineer the name, address, and telephone number of Surveyor before starting survey work.
- B. Submit documentation verifying accuracy of survey work on request.
- C. Submit certificate signed by surveyor, that the elevations and locations of the Work are in conformance with Contract Documents.
- D. Submit information under provisions of Section 01330 - Submittal Procedures.

1.04 PROJECT RECORD DOCUMENTS

- A. Maintain a complete and accurate log of control and survey work as it progresses.
- B. Prepare a certified survey setting forth dimensions, locations, angles, and elevations of construction and site Work upon completion of foundation walls and major site improvements.
- C. Submit Record Documents under provisions of Section 01785 - Project Record Documents.

1.05 EXAMINATION

- A. Verify locations of survey control points prior to starting Work.
- B. Notify Engineer immediately of any discrepancies discovered.

1.06 SURVEY REFERENCE POINTS

- A. Control datum for survey is that established by Owner-provided survey as indicated on Drawings.
- B. Locate and protect survey control points prior to starting site work; preserve permanent reference points during construction.
- C. Notify Engineer 48 hours in advance of need for relocation of reference points due to changes in grades or other reasons.
- D. Report promptly to Engineer the loss or destruction of any reference point.
- E. Contractor shall reimburse Owner for cost of reestablishment of permanent reference points disturbed by Contractor's operations.

1.07 SURVEY REQUIREMENTS

- A. Utilize recognized engineering survey practices.
- B. Establish elevations, lines and levels to provide appropriate controls for the Work.
Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading; fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations, and ground floor elevations.
- C. Verify periodically layouts by same means.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01740
WARRANTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section specifies general administrative and procedural requirements for warranties required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

1.02 SUBMITTAL REQUIREMENTS

- A. Submit written warranties to the OWNER prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the Owner.
- B. Assemble warranties, service, and maintenance contracts, executed by each of the respective manufacturers, suppliers, and subcontractors.
- C. Number of original signed copies required: Two (2) each.
- D. Table of Contents: Neatly types, in orderly sequence. Provide complete information for each item.
1. Product or work item.
 2. Firm, with name of principal, address and telephone number.
 3. Scope.
 4. Date of beginning of warranty, service, or maintenance contract.
 5. Duration of warranty, or service maintenance contract.
 6. Provide information for Owner's personnel:
 - a. Proper procedure in case of failure.
 - b. Instances which might affect the validity of warranty.
 7. Contractor, name of responsible principal, address and telephone number.

1.03 FORMS OF SUBMITTALS

- A. Prepare in duplicate packets.
- B. Format:
1. Size 8-1/2 inches x 11 inches, punch sheets for standard 3-post binder.
 - a. Fold larger sheets to fit into binders.
 2. Cover: Identify each packet with typed or printed title 'WARRANTIES'. List:
 - a. Title of Project.
 - b. Name of Contractor.
 3. Binders: Commercial quality, three-post binder, with durable and cleanable plastic covers and maximum post width of 2 inches.

1.04 WARRANTY SUBMITTAL REQUIREMENTS

- A. For all major pieces of equipment, submit a warranty from the equipment manufacturer. The manufacturer's warranty period shall be concurrent with the Contractor's for one (1) years, unless otherwise specified, commencing at the time of final acceptance by the Owner.
- B. The Contractor shall be responsible for obtaining certificates for equipment warranty for all major equipment specified under Divisions 11, 13, 14, 15 and 16 and which has a 1 HP motor or which lists for more than \$1,000. The Engineer reserves the right to request warranties for equipment not classified as major. The Contractor shall still warrant equipment not considered to be "major" in the Contractor's once-year warranty period even though certificates of warranty may not be required.
- C. For certain pieces of equipment, the OWNER may require a warranty greater than one (1) years. The requirement for extended warranty shall be specified in individual sections of the Specifications.

1.05 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace, or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The Contractor's is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefited from use of the work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the OWNER can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept work for the project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Disclaimers and Limitations: Manufacturer's disclaimers and limitation on product warranties do not relieve the Contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

PART 2 PRODUCTS – (NOT USED)

PART 3 EXECUTION -(NOT USED)

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01785
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Maintenance and Submittal of Project Record Documents and samples.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Maintain one record copy of documents at the site in accordance with the Contract Documents.
- B. Store Record Documents and samples in field office if a field office is required by Contract Documents, or in a secure location. Provide files, racks, and secure storage for Record Documents and samples.
- C. Label each document "PROJECT RECORD" in neat, large, printed letters.
- D. Maintain Record Documents in a clean, dry, and legible condition. Do not use Record Documents for construction purposes.
- E. Keep Record Documents and Samples available for inspection by Resident Project Representative.

1.03 RECORDING

- A. Record information concurrently with construction progress. Do not conceal any work until required information is recorded.
- B. Contract Drawings and Shop Drawings: Legibly mark each item to record all actual construction, or "as built" conditions, including:
 - 1. Measured depths of elements of foundation in relation to finish first floor datum.
 - 2. Measured horizontal locations and elevations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Elevations of underground utilities referenced to bench mark utilized for project.
 - 4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
 - 5. Field changes of dimension and detail.
 - 6. Changes made by modifications.
 - 7. Details not on original contract drawings.
 - 8. References to related shop drawings and modifications.
- C. Record information with a red felt-tip marking pen on a set of blue or black line opaque drawings, provided by Engineer.

1.04 SUBMITTALS

- A. At contract closeout, deliver Project Record Documents to Engineer and prepare the Final "As-Built" data in accordance with Section 01700 Paragraph 1.04 "AS BUILT DRAWINGS"

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 02071

DEMOLITION AND SALVAGE OF OLD STRUCTURES AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Scope: The work covered by this Section consists of furnishing all labor, materials, equipment, supervision, supplies and tools, and performing all operations in connection with the demolition of old structures, portions of old structures, or old equipment, as shown on PLANS, and in accordance with the Contract Documents. Demolition work includes all excavation and backfill to complete the removal hereinafter described.
- B. Work includes:
 - 1. Demolition of existing structures, facilities, and equipment;
 - 2. Salvage of equipment and/or appurtenances;
 - 3. Disposal of excess material and equipment not designated for reuse or salvage;
 - 4. Restoration.

1.02 RELATED REQUIREMENTS

- A. PLANS show equipment and structures designated to be demolished, salvaged, or reused.
- B. Related work as called for on PLANS, or in this or other TECHNICAL SPECIFICATIONS.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300, "Submittals".
- B. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off and/or transfer of utility services and details for dust and noise control.

1.04 QUALITY ASSURANCE

- A. Prior to demolition, a joint inspection by the OWNER, ENGINEER and CONTRACTOR will be made to determine condition of existing structures adjacent to items being demolished. Adjacent structures damaged by demolition operations must be restored to at least pre-existing conditions, at no expense to the OWNER.

1.05 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Operational procedures are at the CONTRACTOR's option but must not interfere with the execution of other work. Materials or equipment designated for reuse or salvage to be carefully removed, transported and stored in approved storage areas as designated by OWNER.
- B. Ownership of Material and Equipment. Certain materials and equipment may be designated for reuse or salvage and are to remain the OWNER's property. If the designated items are damaged during demolition, handling, or storage, the items must be restored to at least pre-existing conditions, at no expense to the OWNER. Materials and equipment not designated for reuse or salvage become the CONTRACTOR's property.
- C. Reuse. Certain items are designated for reuse. Materials and equipment designated for reuse are to be stored and protected until time of installation.
- D. All material such as pipe, timbers, structural steel, railings, etc., which have been designated as salvable for reuse, to be carefully placed in neat piles in approved storage locations as designated by the OWNER.
- E. Dismantle structural steel and equipment without damage; matchmark all pieces prior to disassembly; store on blocks, off the ground, in an upright position to protect against damage.
- F. Where a temporary structure is necessary for a detour adjacent to an existing structure, CONTRACTOR will be permitted to use the material in the old structure for the detour structure, but he is to dismantle and stack or dispose of material as required above, as soon as new structure is complete.
- G. Disposal. All materials and equipment not designated for reuse or salvage to be legally disposed of off-site by the CONTRACTOR.

3.02 PREPARATION

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. CONTRACTOR is responsible for protection of persons and property, Including safe working conditions throughout work progress.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations.
- C. Erect fences, barricades, guardrails, lights, and other similar items around exposed excavations; maintain safeguards until excavations have been completely filled.
- D. Protect from damage, all parts of structures and equipment to remain during all phases of demolition. Execute demolition in a manner to prevent damage from falling debris to OWNER's property or adjacent property.

- E. CONTRACTOR is responsible for safety and maintaining integrity of adjacent structures and, consequently, is liable for any movement or settlement and any resulting injuries or damage. Provide proper bracing and shoring necessary for support. Do not overload floors with equipment and debris.
- F. Do not interfere with use of adjacent facilities; maintain free and safe access at all times. Coordinate work with the OWNER to avoid interference with operation of existing facilities.
- G. Provide enclosed dust chutes with control gates from each floor or elevated area to carry debris to truck beds and govern flow of material into truck. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water daily to keep dust to a minimum.
- H. Protection of Openings: As equipment and piping is removed from exterior walls and floors, install closures over the openings. Closures in exterior walls to be of solid wood or exterior grade plywood, C-C grade, minimum 3/4-inch thick, cut to fit the opening and installed in a manner to shed rain toward the exterior. Anchor wood to the wall in a manner which will not damage the remaining masonry.
- I. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
 - 1. No debris to be permitted to fall or be thrown from buildings; use chutes or remove through interior of buildings to ground level. Do not throw debris down stairwells or down shafts.
 - 2. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. All possible users to be instructed in the use of fire extinguishers.
 - 3. Hydrants to remain accessible at all times. No debris to be permitted to accumulate within a radius of 15 feet of fire hydrants.
 - 4. Fire lines to remain in operation and are to be protected from damage by CONTRACTOR's operations.
 - 5. At least one stairway to be maintained in usable condition to all floors. Keep stairways free of obstructions and debris.
 - 6. Blasting is not permitted.
 - 7. Fires are not permitted unless specifically approved in writing by the OWNER, ENGINEER, and local Fire Marshall.

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

- A. Removing and Replacing Concrete. Use these procedures where existing concrete is to be removed to facilitate operations, and is to be subsequently replaced.
 - 1. Make initial cut with a concrete saw exercising care to avoid cutting reinforcement.
 - 2. After removing concrete, cut cross bars at center of breakout and bend back.
 - 3. Before replacing concrete, bend bars to the original position. Cut the bars so that they will extend into the new concrete by a minimum 20 bar diameters.
 - 4. Immediately before placing new concrete, thoroughly clean old concrete and apply a heavy coat of bonding agent.
 - 5. Replace concrete in accordance with Division 3 - Concrete.

- B. Concrete Structures: Remove concrete structures or concrete portions of structures in sizes not larger than 2 cubic feet. Concrete portions of structures below the permanent ground line which will not interfere in any manner with the proposed construction may be left in place, but removal to be carried at least 2 feet below the permanent ground line and neatly squared off. Cut off reinforcement close to the concrete.
- C. Brick or Stone Structures: Remove brick or stone structures, or stone portions of structures, in sizes not larger than 2 cubic feet. Portions of such structures below the permanent ground line which will not in any manner interfere with the proposed construction may be left in place, but removal to be carried at least 2 feet below the permanent ground line and neatly squared off.
- D. Steel Structures: Dismantle steel structures, or steel portions of structures, in sections of such weight and dimensions as to permit convenient handling, hauling, and storing if material is to be reused or salvaged. Remove rivets and bolts connecting steel railing members, steel beams of beam spans, and steel stringers of truss spans by cutting the heads with a "cold cut" and punching or drilling from the hole or by such other method as will not injure members for reuse if material is to be reused or salvaged. Removal of rivets and bolts from connections of truss members, bracing members, and other similar members in the structure is not required unless specifically called for on the PLANS. CONTRACTOR to have the option of dismantling these members by flame-cutting the members immediately adjacent to the connections. Flame-cutting is not permitted, however, when the structural unit is to be salvaged to permit re-erection. In such case, carefully match-mark all members with paint prior to dismantling, and remove all rivets and bolts from the connections in the manner specified in the first portion of this paragraph.
- E. Timber Structures: Remove timber structures, or timber portions of structures, in such a manner to minimize damage to the timber. Remove all bolts and nails from such lumber. Unless otherwise shown on PLANS, CONTRACTOR may remove entirely or cut off timber piles at a point not less than 2 feet below ground line.
- F. Culverts or Sewers: Unless otherwise shown on PLANS, remove pipe and appurtenances by careful excavation of all dirt on top and sides in such a manner that pipe will not be damaged.
- G. Mechanical or Electrical Equipment:
 - 1. General: Demolish, remove, demount, and disconnect mechanical and electrical materials and equipment indicated to be removed and not indicated to be salvaged or reused.
 - 2. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
 - 3. Demolish, remove, demount, and disconnect the following items:
 - a. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - 1) Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

- b. Perform cutting and patching required for demolition in accordance with applicable Section.

3.04 REPAIR/RESTORATION

- A. Patch, repair, and/or fire stop holes through walls, ceilings, and floors as necessary to maintain fire rating of area.
- B. All portions of below grade hydraulic structures that remain after demolition activities are to have minimum 6-inch diameter holes on a 6 foot grid (center-to-center) placed in the floor slab prior to backfilling operations to allow water to drain from structures. Holes may be cored or removed with impact methods.
- C. Backfill all excavations made in connection with this Section and all openings below natural ground line caused by removal of old structures, or portions thereof, to the level of the original ground line, unless otherwise shown on PLANS. Place that portion of the backfill which will support any portion of a structure, roadbed, or embankment as required for placing structural backfill and embankment. In places inaccessible to blading and rolling equipment, use mechanical or hand tamps or rammers to obtain the required density comparable with adjacent undisturbed material.
- D. Backfilling with rubbish or burying rubbish on the site is not permitted.
- E. Anchor bolts exposed after demolition in concrete walls or floors to be cut back at least one inch below the surface and patched with cement grout to provide a smooth surface.
- F. Pipe supports to be removed includes removal of existing anchor bolts, and concrete based anchor bolts to be cut back one inch below the surface and patched smooth with cement grout.

3.05 CLEANING

- A. Cleaning: Keep the work areas free of accumulated debris. Materials and equipment that are not designated for reuse or salvage to be removed from the site weekly, unless otherwise approved.
- B. Disposal and Cleanup: Debris, including concrete, non-reusable brick and stone, metals and similar materials and non-salvaged equipment to become property of CONTRACTOR. Remove from the site and legally dispose of demolished materials and equipment which are not to be salvaged.
- C. Upon completion of work of this Section and after removal of all debris, structure to be broom clean and site to be left in clean condition satisfactory to OWNER.

END OF SECTION

(THIS PAGE LEFT INTENTIONALLY BLANK)

SECTION 02315
EXCAVATION, TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This specification includes the requirements for excavation, bedding, backfilling and compaction, of utility trenches for water and sewer mains and associated appurtenances.

1.02 WORK OF THIS SECTION SPECIFIED ELSEWHERE

- A. Section 02161 - Trench Excavation and Shoring Safety Plan
- B. Section 02240 - Dewatering Excavations
- C. Section 02360 - Vegetation Restoration

1.03 REFERENCES

- A. . ASTM D1557 - Laboratory Compaction Characteristics of Soil.
- B. Department of Labor, Occupational Safety and Health Administration 29 CFR Part 1926, Occupational Safety and Health Standards - Excavations; Final Rule (OSHA).
- C. Follow the latest edition of the above references.

1.04 DEFINITIONS

- A. Soil types are defined as follows.
 - 1. Trench Excavation. Excavation of soil for the purpose of installing water and sewer mains, their appurtenances, and for the restoration of surface features. The excavated material may be classified as either clay or sandy soil, a mixture of each, and may contain varying amounts of loam, silt, gravel, organic material, or rock fragments less than one (1) cu yd in volume. Trench excavation excludes all material defined as Rock Excavation and Unsuitable Soil.
 - 2. Rock Excavation. Excavation of naturally occurring deposits of limestone, sandstone, shale or other indigenous rock occurring as bedrock, rock ledges, outcroppings, or boulders, one (1) cu yd or larger in volume necessitating removal by the use of systematic drilling, expansive jacks, or backhoe mounted pneumatic hole punchers or rock breakers.
 - 3. Unsuitable Soil Materials. This soil material includes varying amounts of material classified as slag, cinders, trash, debris and rubble; organic or contaminated soil and material; asphalt and concrete pavements (including aggregate sub-base); sidewalks and curbs; concrete slabs concrete or masonry foundations; metal beams, bracing, and sheet piling; or similar matter.

1.05 SUBMITTALS

- A. Submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples must be submitted in accordance with Section 01300.
- B. Provide to the Owner copies of all contractual agreements, permits and/or licenses for proposed disposal sites for all material and waste removed from the job site.
- C. Provide to the Owner, prior to the use of any materials in this Section, certified test and inspection reports that all materials to be utilized in this work are in accordance with the Contract Documents.
- D. Shop Drawings:
 - 1. Plating of Excavations: When requested submit design calculations stamped by a Professional Engineer licensed in the State of Texas as proof of the structural integrity of the plating provided.
 - 2. Calculations: Submit appropriate design calculations to support Shop Drawings. Include maximum theoretical deflections of supporting members. Include calculations indicating the expected magnitude of vertical and lateral movement.
- E. The Contractor, before starting work, must submit to the Owner for approval, a layout of his construction procedures and the equipment to be used in maintaining the trees in place without damage.

1.06 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

PART 2 - PART 2 - PRODUCTS

2.01 BEDDING AND BACKFILL

- A. Bedding Stone
 - 1. Pipe bedding stone shall be clean gravel, crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C 33 for stone quality. Size gradation shall conform to ASTM C-33 No. 57 or No. 67 or the following Table:

SIEVE SIZE	% RETAINED BY WEIGHT
1-1/2"	0
1"	0-10
1/2"	40-85
#4	90-100
#8	95-100

B. Bedding and Backfill Sand

1. Sand for pipe bedding and backfill must be clean, granular and homogeneous material composed mainly of mineral matter, free of mud, silt, clay lumps or clods, vegetation or debris. The material removed by decantation TxDOT Test Method Tex406- A, plus the weight of any clay lumps, must not exceed 4.5 percent by weight.
2. The resistivity must not be less than 3000 ohms-em as determined by TxDOT Test Method Tex-129-E. Size gradation of sand for bedding must be as follows:

GRADATION TABLE	
SIEVE SIZE	% RETAINED BY WEIGHT
1/4"	0
#60	75-100
#100	95-100

2.02 CONTROLLED LOW STRENGTH MATERIAL, CLSM (FLOWABLE FILL MATERIAL)

- A. Contractor must provide CLSM mix design prepared by a qualified commercial laboratory and reviewed and signed by a licensed Texas Professional Engineer.

2.03 AGGREGATE FOR STABILIZATION OF TRENCH BOTTOMS

- A. When required aggregate used to stabilize trench bottoms must have an aggregate such that the majority of the material passes a 1 ½ to 2 ½ -inch sieve, with no more than 10% of the material passing the No. 16 sieve.

PART 3 - PART 3 - EXECUTION

3.01 WORK AREA PREPARATION

- A. Existing Work Area Condition
 1. All information on subsurface exploration available to the Owner, if any, will be made available to the Contractor for examination. However, the Owner in no way takes responsibility for, the interpretation, accuracy, or thoroughness of the information. It will be the responsibility of the Contractor to make such subsurface explorations as deemed necessary, to supplement information provided by the Owner, at no additional cost to the Owner.
 2. Prior to excavating, thoroughly investigate the limits of the proposed trench to ascertain the existence and location of any underground structures, existing utilities or other items that might interfere with the pipe installation. Notify the Owner of any obstructions that will prevent the installation of the pipe or appurtenances as indicated on the Drawings.

- B. Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected as set forth in "General Conditions".
- C. Clearing Work Area
1. Before starting trench excavation, all obstructions, which must be removed or relocated, must be cleared. Pavement, curbs, walks, trees, shrubs, utility poles, and other structures, which are to be preserved, must be properly braced and protected. Unless otherwise shown or directed by the Owner, all trees and large shrubs must be preserved with minimal damage inflicted on the root structure. When required, small trees and shrubs may be removed and replaced with equivalent specimens if approved in advance by the
 2. Owner.
- D. Segregation and Disposal of Soil Material
1. Topsoil suitable for final grading and landscaping, and excavated material suitable for backfilling, as described in Section 02360, - Vegetation Restoration, may be stockpiled separately within the Work Area if approved by the Owner.
 2. Surplus excavated material and excavated material unsuitable for backfilling, final grading, and landscaping, must be transported off of the Site and disposed of in disposal areas obtained by the Contractor and approved by the Owner.
 3. Excavated material must not be stockpiled along the route of the work unless authorized beforehand by the Owner.
- E. Pavement Removal
1. The Contractor must saw cut all concrete and asphalt pavements to their full depth prior to breaking and removing the pavement. On pavements consisting of an asphalt overlay on a concrete base, the Owner reserves the right to order the removal of up to 6 additional inches beyond the edge of the concrete base. This additional asphalt removal must be removed to a neat saw cut edge and will be considered incidental to the Work.
 2. Utilizing drop weight equipment for the purpose of breaking the pavement is not permitted.
- F. Protection or Removal of Existing Trees
1. The Contractor is not permitted to remove trees beyond the limits of the trench excavation except as specified in these Specifications, or as shown on the Plans, or as ordered by the Owner.
 2. The Contractor must arrange his construction operations and use the necessary equipment required, so as not to remove or damage any existing trees due to the Work to be performed under this Contract.
 3. To protect the trunks of existing trees from damage, the Contractor must place 2" x 4" boards, six (6) feet long, vertically and about 6 inches apart around all trees located in the parkways along the route of the work. The boards must be held in place by wire looped around the circumference of the tree trunk. After completion of all work, the protective boards and wires must be carefully removed.

4. Any pruning of trees and roots required to permit the operation of the Contractor's equipment must be kept to a minimum, subject to the approval of the Owner, and must be done symmetrically by a licensed arborist. The arborist is required to obtain any necessary permits to trim and spray or in any way affect the general health or structure of trees in the public way.

G. Excavating Over or Adjacent to Existing Utilities

1. The Contractor must verify the location of existing utilities in the vicinity of the work before starting construction. The Contractor is responsible for protecting, and repairing utilities damaged by the work under of this contract, at no additional cost to the Owner. The Contractor must coordinate all work with the owner of the utility.
2. The Contractor shall conduct his Work such that a reasonable minimum of disturbance to existing utilities will result. Particular care shall be exercised to avoid the cutting or breakage of all existing utilities. If at any time the Contractor damages the utilities in place through his operations, the Contractor shall immediately notify the owner of the utility to make the necessary repairs. When active wastewater sewer lines are cut in the trenching operations, temporary flumes shall be provided across the trench while open and the lines shall be restored when the backfilling has progressed to the original bedding lines of the sewer so cut.
3. The Contractor shall inform utility owners sufficiently in advance of the Contractor's operations to enable such utility owners to reroute, provide temporary detours or to make other adjustments to utility lines in order that the Contractor may proceed with his Work with a minimum of delay and expense. The Contractor shall cooperate with all utility owners concerned in effecting any utility adjustments necessary and shall not hold the City liable for any expense due to delay or additional Work because of conflicts arising from existing utilities.
4. Wherever existing utility branch connections, sewers, storm drainage structures, drains, conduits, ducts, pipes or structures present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impractical, a deviation from line and grade may be ordered by the Engineer and the change shall be made in the manner directed.
5. Adequate temporary support, protection and maintenance of all underground and surface utility structures, drains, sewers and other obstructions encountered in the progress of the Work shall be furnished by the Contractor, at his expense and as approved by the Engineer.

H. Plating of Excavations

1. Unattended excavations in public streets, alleys, driveways, and walkways necessitated by the work must be plated, if the excavation has not been backfilled, or a temporary paved surface has been provided, or specifically authorized otherwise by the Owner.

2. Steel Plate(s) must be large enough to safely span the excavation with sufficient overlap beyond the edge of the excavation to provide firm support as appropriate for the type of pavement and soil encountered. Plate(s) must be firmly bedded and secured to the adjacent pavement to prevent rocking or movement, and of adequate thickness to carry anticipated loads. When plating is left in place during off-work periods, or if the Owner feels vehicular or pedestrian safety may be compromised, a bituminous ramp is to be provided at the perimeter of the plate(s) as appropriate to provide a smooth transition between the surface of the plate(s) and the adjacent pavement or walkway.
3. Plating subjected to vehicular traffic must be capable of carrying AASHTO H20 traffic loading without movement or excessive deflection. The plating must be secured to the adjacent paved surface in such manner so as to prevent rocking or other movement which could expose the excavation. The name of the Contractor must be indicated on both sides of the plating.
4. When steel plates are used and left in place beyond normal working periods, a bituminous ramp must be provided at the perimeter of the plate(s), to provide a smooth transition between the surface of the plate(s) and the adjacent street pavement or walkway, unless authorized otherwise.
5. Plating of excavations is not intended as a substitution for providing traffic control, which must be provided in accordance with Contract Documents.

3.02 EXCAVATION PROTECTION

A. General Requirements

1. Excavations must be protected in accordance with applicable rules, laws and regulations of Federal, State and City ordinances applicable to underpinning, shoring of excavations, and other work affecting adjoining property and the safety of worker, but must not be less than the standards and regulations established by OSHA. Provide trench protection and excavation safety systems in accordance with Section 02161.
2. Structural support systems are required for all excavations exceeding five (5) feet in depth. Structural support systems are to be used in all excavations in soils that are determined to be unstable or subject to cave-ins, regardless of the depth of the excavation.
3. The Contractor must remove and replace, or provide the means to support any surface features when their location poses a hazard to workers in the excavation.
4. Whenever excavations cross the location of an existing underground utility, the Contractor must proceed with caution and use appropriate methods of excavation to avoid damaging the utility. The Contractor is responsible for coordinating all work with the owner of the utility.
5. Ramps, runways or ladders must be provided for ingress and egress by workers from excavations exceeding four (4) feet in depth in accordance with OSHA.
6. Surface or ground water entering excavations must be controlled by the use of appropriate equipment. If the trench interrupts the natural flow of surface water, diversion ditches or dikes must be used.

B. Protection of Adjacent Structures

1. When the stability of adjoining buildings, walls, sidewalks, pavements or other structures are endangered by the excavation operations, structural support systems such as shoring, bracing or underpinning must be used to ensure the stability of the structure.
2. The Contractor is responsible for posting and issuing all notices required to inform adjacent or adjoining property owners or other parties and such notice or notices must be served in sufficient time as not to delay the progress of the Work under this Contract.
3. 3. Excavation below the foundation of an adjacent structure requires either of the following:
 - a. A Professional Engineer licensed in the state of Texas has determined that the structure is located far enough away from the excavation so as to be unaffected, or
 - b. A Professional Engineer licensed in the state of Texas has designed and approved a structural support system to provide adequate protection to the existing structure.

C. Structural Support Systems

1. Structural support systems may consist of pre-engineered systems such as aluminum hydraulic shoring, trench shields, trench boxes, or systems constructed on the job site such as timber or steel shoring or steel sheet piling. Provide trench excavation safety system and shoring in accordance with OSHA and Specification Section 02161 - Trench Excavation and Shoring Safety Plan.

3.03 EXCAVATION

A. Trench Excavation (Open Cut)

1. The width of the trenches must provide adequate space for workers to place and join the pipe properly, and must be kept to the minimum practical width. Trenches for water, reclaimed, and wastewater lines shall have a clear width on each side beyond the outside surfaces of the pipe bell or coupling of not less than 6 inches nor more than 12 inches.
2. The Contractor must excavate a minimum of 6-inches below the bottom of the pipe unless otherwise shown, specified, or directed, so bedding material can be placed in the bottom of the trench and shaped to provide a continuous firm bearing for the pipe barrel. Bell holes must be provided for proper make-up of the joints.
3. The open excavated trench preceding the pipe laying operation and the unfilled trench with pipe in place must be kept to a minimum length causing the least disturbance. The maximum length of open trench must not exceed 100-feet unless otherwise directed by the Owner.
4. Contractor must saw cut existing pavement prior to excavating. Width of saw cut pavement must be such that any sheeting provided for excavation protection is not in contact with the pavement.

5. Before attempting to lay pipe, all water, debris, loose material, etc, encountered in trench must be pumped or bailed out and the trench must be kept clean and dry while the pipe is laid and backfilled. Where water is encountered in the excavation, the excavation must be dewatered in accordance with Section 02240 - Dewatering Excavation of these specifications.
- B. Rock Excavation (open cut)
1. Whenever rock, stone, masonry or other hard, unyielding material is encountered at or above the required trench bottom elevation, remove it to provide a clearance of no less than 8-inches below and 6-inches on each side of pipes and associated fittings, valves and other appurtenances. Backfill the over excavated area with granular bedding material.
 2. Removal of Rock by blasting or by use of a drop hammer is not permitted under this contract.
 3. Excavate rock as near as practicable to the outside shape of the work as shown on the Plans. Solid rock, not loosened from the adjacent solid rock, may extend within the neat outside surfaces of these shapes no more than two (2) inches, provided that on any ten (10) foot section of the excavation the total area of such projection at the neat outside surface of the sections does not exceed twenty (20) percent of the area of that section
 4. The Contractor is required to remove all loose rock and other material from the excavation. In the event that the excavation is enlarged beyond the outside shape of the sewer or sewer structures as shown on the Plans, the Contractor will not be entitled to any payment for the additional concrete needed to fill the voids caused by such over-breakage.
- C. Trench Excavation (Short Tunnel Construction)
1. In some instances, trees, fire hydrants, sidewalks, and other obstructions may be encountered, the proximity of which may be a hindrance to open cut excavation. In such cases, the Contractor must excavate by means of short tunnels in order to protect such obstructions against damage. Short tunnel work will be considered incidental to the construction and no additional payment will be allowed.
- D. Additional Trench Excavation
1. If the soils encountered at the elevations specified are not suitable, or it is determined necessary to go to an additional width and depth the excavation must be carried to such additional width and/or depth. Contractor must fill such excavated areas with approved backfill material as required or directed by the Owner.
- E. Unauthorized Excavation
1. Wherever the excavation is carried beyond or below the lines and grades shown on the Drawings all such excavated space must be refilled with select fill materials and in such manner as may be directed in order to insure the stability of all affected structures. Beneath all structures, space excavated without authority must be refilled by the Contractor with approved backfill materials and will be considered incidental to the construction and no

additional payment will be allowed.

F. Trenching Across or Over Existing Excavations or Utility Trenches

1. In the event that the trench passes over or through a previous excavation, carefully compact and stabilize the bottom of the new trench or excavation to a density equal to or greater than 95% of the maximum dry density as determined by ASTM 01557. Perform this compaction carefully to avoid damaging the existing utility or structure.

G. Special Excavation

1. 1. Remove unsuitable materials to provide 2-foot minimum horizontal and vertical clearance around water mains or related structures as applicable, unless otherwise directed by the Owner.

3.04 PLACEMENT OF PIPE BEDDING

A. Pipe Bedding

1. Pipe laid in trenches must be bedded in accordance with the details shown on the Drawings.
2. Existing underground structures, tunnels, conduits, and pipes crossing the excavation must be bedded with compacted sand. Bedding material must be placed under and around each existing underground structure, tunnel, conduit, or pipe as required to stabilize the excavation.
3. At each joint, enough depth and width must be provided around the pipe so that joints can be properly made up.

B. Bedding Placement - Vaults and Structures

1. Pipe bedding beneath precast bases, cast-in-place bases and other foundations must be 6-inches in thickness and thoroughly compacted in place to not less than 95% of the maximum dry density as determined by ASTM 01557.

C. Bedding and Backfill for Short Tunnel

1. Pipes placed in short tunnels must be bedded in sand. The annular space between the pipe and undisturbed earth must be completely filled with compacted sand fill material. Pipelines in short tunnels must be supported to permit the placement of backfill.

3.05 BACKFILLING EXCAVATIONS

A. General

1. All excavations must be backfilled to the original surface of the ground or to such other grades shown on the Drawings or as directed by the Owner. For areas to be covered by topsoil, backfill must be left 6-inches below the finished grade or as shown on the Drawings, or directed by the Owner. All backfilling must be done as soon as possible after water main piping has been installed and inspected, and as soon as mortar for masonry or thrust blocks have sufficiently set, unless directed otherwise by the Owner.
2. Unsuitable material and material rejected by the Owner must immediately be removed from the Site and disposed of by the Contractor at his expense.

3. Construction equipment used to backfill against and over cast-in-place concrete structures must not be permitted to travel over these structures until the designated concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, as determined by the Owner, the above restriction may be modified if the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

B. Backfill Procedure

1. Sand fill material must be used for backfill where roadways, driveways, sidewalks, or other pavements are to be placed on the backfill or where the edge of the trench excavation is 5-feet or less from any roadway pavement, and in trenches crossing pavements or sidewalks for a distance beyond the edge of the pavement or sidewalk equal to the depth of the trench. Sand fill material must be used as backfill in trenches parallel to roadways, driveways, or other pavements from the top of the bedding to a depth below the ground surface equal to the distance between the inner face of the trench and the closest edge of the pavement.
2. Where pavements and appurtenances for streets are to be placed over the trenches, the backfill material must be placed in uniform layers not greater than 6-inches in thickness and compacted in place. Each layer must be compacted to or not less than 95% of the maximum dry density as determined by ASTM 01557.
3. All pipe sewers must be surrounded and covered by trench backfill above the granular embedment as soon as they are laid. The trench backfill must be properly compacted and tamped to a depth of at least one foot above the top of the pipe prior to placing the remainder of backfilling.
4. Excavated material can be re-used as backfill only if directed or approved by the Owner.
5. Where railroad tracks or pavements for highways are to be placed over trenches, the backfill must be placed in conformance with the standards set forth by the respective agency having jurisdiction over the railroad or highway.
6. Trench backfilling work must be done in such a way so as to prevent damage to any pipe, utility, or structure.
7. On monolithic concrete sewers and structures cast-in-place, trench backfill must not be placed until the concrete has attained a compressive strength of 2,000 psi.

C. Backfill under a Supported Water Main

1. Backfill the open trench under the water main and 10-feet beyond the water main sides with approved material up to a level of 1-foot below the invert of the supported water main. The backfill material must be placed in layers of 12-inches with each layer mechanically compacted to 95% of the maximum dry density as determined by ASTM 01557.
2. Place pipe bedding material from 1-foot below the water main invert to the water main centerline and compact to achieve 95% of the maximum dry density as determined by ASTM 01557.

3. Remove the water main pipe support systems, supporting beams, and pipe support straps; and cut-off and remove soldier piles to a level at least 4-feet below finished grade.
4. The water main pipe must be inspected for leakage and joint integrity and repaired if necessary, prior to backfilling above the water main.
5. After approval by the Owner, continue backfilling with approved material. The open trench must be backfilled up to the required sub grade level. The backfill material must be placed in layers of 12-inches with each layer mechanically compacted to 95% of the maximum dry density as determined by ASTM 01557.

D. Backfilling with Controlled Low Strength Material (CLSM) - Flowable Fill

1. Do not place the mix on frozen ground, in standing water, or during wet weather conditions. Mixing and placing may begin only if the air temperature is 35°F minimum and rising. At time of placement, the material temperature must be 40 ° F minimum. Mixing and placing must stop when the air temperature is 40 °F and falling.
2. Place the mix directly from the chute into the space to be filled. Other placement methods may be approved by the Owner if the mix design is appropriate.
3. When backfilling against structures, place the mix in layers to prevent damage by lateral pressures. Side slopes must be stepped or serrated to prevent wedging action of the backfill against the structure. Allow each layer to harden prior to placing the next layer.
4. When backfilling pipe trench, distribute the mix evenly on each side of the pipeline to prevent movement.
5. The mix must not be exposed to freezing temperatures or wet weather conditions during the first 24 hours after placement.
6. The mix may be subjected to loading upon approval by the Owner, or when a penetration of 39 mm/blow or less has been obtained with the Dynamic Cone Penetrometer test.

E. Utility Line Abandonment with GROUT / CLSM Backfill

1. Do not place the mix in frozen pipe or in standing water. Mixing and placing may begin only if the ground temperature is 35°F minimum and rising. At time of placement, the material temperature must be 40 °F minimum. Mixing and placing must stop when the air temperature is 40 °F and falling.
2. Place the mix directly from the chute into a pump to discharge into the pipe being filled. Other placement methods may be approved by the Owner if the mix design is appropriate.
3. Provide openings into the pipe being filled to allow air to escape and to monitor filling progress.
4. The mix must not be exposed to freezing temperatures or wet weather conditions during the first 24 hours after placement.

3.06 FINISH GRADING

- A. Finish grading must be performed in accordance with the completed contour elevations and grades shown and must be made to conform to the existing ground surface. All finished graded surfaces must be left smooth and firm and graded to permit positive drainage.

END OF SECTION

SECTION 02687
TESTING OF INSTALLED PIPING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope: Furnish all labor, materials, tools, and equipment, and perform all operations in connection with testing of installed piping systems and appurtenances.
- B. PLANS show pipe sizes, arrangements, working pressures, and test pressures. When PLANS lack such information, minimum test pressures specified in Attachment "B" herein to be used.
- C. Related Work: Piping materials and installation requirement as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATIONS Sections.

1.02 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part. Above Ground

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. All testing to be conducted in the presence of ENGINEER and/or local reviewing authority. A minimum of 24 hours notice is required prior to commencing tests. Length of piping and sections included in tests to meet with approval of ENGINEER.
- B. Water for Testing
 - 1. Except for potable water lines, non-potable water may be used for testing.
 - 2. CONTRACTOR is responsible for conveying and ultimate disposal of water used for testing.
 - 3. If potable water is used for testing CONTRACTOR is responsible for metering.
 - 4. Reference the General Conditions for the disposition of costs associated with the purchase of potable water or non-potable water.
 - 5. All costs associated with re-testing to be borne by CONTRACTOR.
- C. Furnish all taps, fittings, blind flanges, bulkheads, bracing systems, plugs, and other devices for use in filling, flushing, and testing.
- D. Piping installed behind walls, under pavement, or under structures to be tested prior to construction of same.

- E. Thrust Blocks: No testing is to be performed until the installation of all thrust blocking has been completed and given sufficient time to cure. Testing is not to begin until a minimum of 36 hours has elapsed since the last thrust block has been poured when utilizing high, early strength concrete for thrust blocking. A minimum of 7 days of thrust block curing is required when utilizing standard concrete.
- F. Pipes to be free of dirt, sand, gravel, or other foreign material prior to testing.
- G. Protect all valves and appurtenances, in or attached to piping system, from damage due to testing procedures. Any damage resulting from testing procedures to be repaired, and all costs to be borne by CONTRACTOR.
- H. When testing absorbent pipe materials, such as concrete, fill the system with water and allow to stand for 24 hours prior to conducting test. Air testing is not to be used with these materials.
- I. All fittings, hydrants, and appurtenances to be properly braced and harnessed before the testing commences. Thrust restraining devices which are part of the piping system to be tested at the test pressure.
- J. Plug pipe outlets with test plugs, blind flanges or bulkheads. Brace valves, fittings, and plugs securely to prevent blowouts.
- K. Furnish adequate venting facilities in system to allow air to escape when filling system for hydrostatic testing.
- L. Pressurizing equipment to include a regulator set to avoid over-pressurization of test lines.
- M. M. CONTRACTOR is solely responsible for implementing and adhering to recognized safety procedures to prevent injury to personnel and/or damage to property.
- N. For underground lines, backfill to a sufficient depth of cover prior to testing to prevent shifting of the pipe due to pressure.
- O. CONTRACTOR to determine groundwater level by installing groundwater gauges in manholes prior to conducting low pressure air tests or testing underground pipes for infiltration and/or exfiltration. Gauges to consist of a rigid section of minimum 1/2-inch diameter pipe, capped and inserted horizontally in manhole wall as near as possible to top of sewer, sealed so as to be watertight. Immediately prior to performance of test, groundwater back pressure to be determined by removing pipe cap, blowing air through pipe into ground to clean pipe, then connecting a clear plastic tube to pipe. Clear plastic tube to be held vertically and measurement of height (in feet) of water over invert of pipe to be taken after water has stopped rising. Upon completion of air test, remove groundwater gauge from wall of manhole and permanently close opening with a non-shrinking, noncorrosive grout.
- P. Test pressure is not to exceed rated pressure of valves installed in line.

3.02 HYDROSTATIC TESTING

- A. Test Pressure: Unless otherwise specified in the test schedule herein or the piping schedule on the PLANS, the following pressure restrictions to apply:
 - 1. Test Pressure
 - a. 150% of the working pressure at the point of testing; or

- b. 125% of the working pressure at the highest point along the test section.
 - c. In the event of a conflict between a. and b. above, the greater value is to apply.
 2. For surcharged piping systems, working pressure is defined as the difference in elevation between the lowest point in the piping system and the maximum water surface elevation in the hydraulic structure immediately upstream of the piping system.
 3. Test pressure is not to vary by more than plus or minus 5 psi.
- B. Duration of Pressure Test: Exposed joints to be tested for not less than 2 hours with no allowable leakage. Covered joints to be tested for a minimum of 6 hours. If leakage at the end of the 6-hour period exceeds the allowable by less than 25%, test to continue for not less than 18 additional hours. For test durations greater than 2 hours, furnish a calibrated pressure recorder to record pressure during test. Reference Paragraph 3.07 for allowable leakage.
- C. Pressurization: Each valved section of pipe to be filled with water slowly and the specified test pressure, based on the elevation of the highest point of the line or section under test and corrected to the elevation of the test gauge, to be applied by means of a pump connected to the pipe. Furnish pump, pipe connections, and necessary apparatus, gauge, volumetric measuring device and meters. Furnish necessary labor and assistance for conducting test, all subject to approval by ENGINEER.
- D. Air Removal: Before applying the specified test pressure, air to be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, CONTRACTOR to install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks to be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks to be removed and plugged, or left in place at the discretion of the OWNER.
- E. Examination: All exposed pipe, fittings, valves, hydrants, and joints to be examined carefully during the test. Any damage or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test to be repaired or replaced with sound material and the test repeated until the leakage is within the specified allowance.

3.03 LOW PRESSURE AIR TEST

- A. Equipment: Equipment used to meet following minimum requirements.
 1. Pneumatic plugs to have a sealing length equal to or greater than diameter of pipe tested.
 2. Pneumatic plugs to resist internal test pressures without requiring external bracing or blocking.
 3. One of the pneumatic plugs to have inlet tap or other provision for connecting air supply to introduce low pressure air into the line for testing.
 4. All air used shall pass through a single control panel:
 - a. From control panel to pneumatic plugs for inflation.
 - b. From control panel to a sealed line for introducing low pressure air.
 - c. From sealed line to control panel for continuous monitoring of air pressure in sealed line.

5. Air supply system to have necessary valves and gauges to control rate at which air enters test section and for reading test results.
6. Pressure gauges to have minimum graduations of 0.1 psi, an accuracy of plus or minus 0.04 psi, and a minimum dial diameter of 3 ½ inches.

B. Procedure

1. Isolate test section by installing air-tight plugs. Plug ends of branches, laterals, and wyes which are to be included in test section. Brace all plugs to prevent slippage and blow-out.
2. CONTRACTOR to carefully observe safety precautions during air testing to prevent injury to personnel from plugs blowing out. No one allowed in manholes during test.
3. Inflate pneumatic plugs to 25 psig.
4. Slowly introduce low pressure air into sealed line until pressure reaches test pressure plus 0.5 psig.
 - a. a. Test pressure to be 3.5 psig.
 - b. b. The maximum pressure allowed under any condition in air testing to be 10 psig.

The maximum groundwater level for air testing is 13 feet above top of pipe.
5. Allow a minimum of 2 minutes for temperature and pressure of the air to stabilize. Add air as required to maintain internal pressure specified plus or minus 0.5 psig.
6. When internal air pressure has stabilized and is at or above test pressure, disconnect air supply and commence test. Utilizing a stopwatch, record period of time required for pressure to drop 1.0 psig from starting pressure. Following table lists minimum test times for various pipe sizes. If time for pressure to decrease 1.0 psig is less than value in table, then system has failed.

PIPE SIZE	MINIMUM TEST TIME	
	MINUTES	SECONDS
6"	2	50
8"	3	56
10"	4	43
12"	5	40
15"	7	5
18"	8	30
21"	9	55
24"	11	20
27"	12	45
30"	14	10
36"	17	0
42"	19	50
48"	22	36
54"	25	16
60"	27	47

For other sizes, consult with ENGINEER.

7. Test may be discontinued when prescribed minimum test time has been reached, even though 1.0 psig pressure drop has not occurred.
8. Release air from pipe slowly and remove plugs at conclusion of test.

3.04 HIGH PRESSURE AIR TESTING

- A. Purge line to be tested with water or high velocity air as appropriate to system being tested.
- B. Unless otherwise specified, perform two-hour pressure test at 150 psig using dry, oil free air. Unless otherwise specified, no leaks will be allowed.
- C. Test joints with soapy water solution for leaks.

3.05 EXFILTRATION TESTING

- A. General: Take precautions required to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at CONTRACTOR's expense. Conduct test in presence of ENGINEER.
- B. Preparation: Seal ends of section being tested with water-tight plugs. Fill section with water 24 hours prior to start of test. Vent line during filling so that no air is trapped in line. Leave outlets of stacks, inlets, and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe or by plugging. After completion of satisfactory test, remove lengths of pipe added for test.
- C. Duration of Test: Test for at least 2 hours with minimum head of 4 feet measured above top crown, inside pipe at upper end of section being tested.
- D. Allowable Leakage: Allowable leakage or exfiltration in any individual section or entire sewer line under construction is defined in Paragraph 3.07. Remove and replace or make approved corrective repairs to any section or line which has leakage or exfiltration that exceeds above amount. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. For this purpose, any steady stream will be considered a leak, while a drip will not. Individual leaks ordinarily will be revealed by looking through sewer with a light while groundwater level is over sewer, during backfill operations, or immediately after water from exfiltration tests is emptied from sewer line. Settlement in backfill during exfiltration tests will be taken and an indication of leakage.
- E. Measurement of Leakage: Measure leakage or exfiltration during test period by adding measured quantities of water to maintain water level in test structure. Quantity of water added to maintain water level is amount of leakage or exfiltration.
- F. Retest: Sewers failing to meet requirements of leakage test to be tested again for leakage after repair by CONTRACTOR. No sewer will be accepted until leakage is less than allowable.

3.06 INFILTRATION TESTING

- A. General: Infiltration tests will be allowed only when the water table gauges determine the groundwater level to be 2 feet or more above the highest point of the pipeline section being tested. CONTRACTOR to furnish all equipment required for testing. Take precautions to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at CONTRACTOR's expense. Conduct test in presence of ENGINEER.
- B. Preparation: Seal all service laterals, stubs, fittings, and all appurtenances of the upstream end of section being tested with watertight plug(s). Install approved 90-degree, V-notch weir in lower manhole of section to be tested. Weir to be of sufficient size to accommodate flow. Install weir with watertight bulkhead to avoid leakage around bulkhead and weir. Notch of weir to be below centerline of line to be tested and be in the upstream end of manhole or joint of pipe. Pump water from downstream of weir so that water will have a free fall over weir at all times.
- C. Duration of Test: Test for 4 hours after downstream sewer is pumped down. Take measurements of head on weir at 3D-minute intervals. Volume of infiltration to be calculated by use of standard V-notch weir tables for rate of flow and time of tests.
- D. Allowable Leakage: Allowable leakage or infiltration in any individual section or entire sewer line under construction is defined in Paragraph 3.07. Remove and replace or make approved corrective repairs to any section or line which has leakage or infiltration that exceeds above amount. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. For this purpose, any steady stream will be considered a leak, while a drip will not. Individual leaks ordinarily will be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations.
- E. Retest: Sewers failing to meet requirements of leakage test will, after repair by CONTRACTOR, be tested again for leakage. No sewer accepted until leakage is less than allowable.

3.07 ALLOWABLE LEAKAGE FOR NONPRESSURE PIPELINES

- A. The allowable leakage (exfiltration or infiltration) for non-pressure pipelines is not to exceed the following:

TYPE OF PIPE	LEAKAGE (GALLONS PER 24 HOURS PER INCH OF DIAMETER PER 1,000 FEET OF PIPE)
Ductile iron-mechanical or push-on joints	10
Polyvinyl chloride, thermal plastic or fiberglass with solvent-cemented joints, or centrifugally cast fiberglass pipe and fittings	10

Concrete with rubber joints	20
Concrete with steel and rubber joints	10
Clay with rubber gasket joints	20
Cast iron soil pipe:	
1. Drains and Vents	0
2. Sewer Laterals	*
All piping inside structures	0

* The same allowable as pipe to which it is connected.

- B. Regardless of the above allowable leakage, any visible leaks detected to be permanently stopped.

3.08 PIPELINE SETTLEMENT TESTING

A. TV Inspection

1. During infiltration test or after exfiltration test, pipe to be TV inspected for possible settlement. When air testing has been used, run water through pipe to permit meaningful observations. Any pipe settlement which causes ponding of water in pipe is an indication of system failure.
2. TV inspection required on all sanitary sewers greater than 30 inches in diameter and all sewers installed with curved alignment.

- B. Mandrel Testing: All plastic piping materials used for gravity sewers to be subjected to a 95% mandrel test. Mandrel testing to be completed no sooner than four weeks after backfilling has been completed. A Go-No-Go deflection testing mandrel with a minimum of eight runners to be used for testing. Mandrel to be furnished with proving ring. Dimensions of the mandrel for SDR-35 PVC, to be as shown in Attachment "A" to this Section. For other wall thicknesses, consult ENGINEER. Testing to be as follows:

1. Completely flush line and clean pipe of debris.
2. Install pull rope in section to be tested.
3. Attach pull rope and retrieval rope to mandrel.
4. Insert mandrel in pipe. Remove slack from pull rope and place tape marker on rope at end of pipe where mandrel will exit. Tape marker to be used to determine mandrel location in line.
5. Using guide pulleys, pull mandrel through line. Use tape marker to determine location of over-deflected sections.
6. All pipe sections failing to pass the mandrel to be removed and reinstalled.
7. Repeat testing until system passes.

3.09 LEAKAGE TESTING FOR PRESSURE PIPELINES

- A. Leakage test to be conducted concurrently with hydrostatic pressure tests.

- B. Leakage Defined: Leakage is defined as the quantity of water that must be supplied into pipe, or any valved section thereof, to maintain pressure within specified test pressure after air in pipeline has been expelled and pipe has been filled with water and brought to test pressure.
- C. Determine rate of leakage at 15-minute intervals by means of volumetric measurement of makeup water added to maintain test pressure. The test to proceed until the rate of leakage has stabilized or is decreasing below an allowable value, for 3 consecutive 15-minute intervals. After this, test pressure to be maintained for at least another 15 minutes.
- D. The allowable leakage for pressure pipelines including surcharged gravity lines not to exceed the following in gallons per 24 hours per inch of diameter per mile of pipe:

TYPE OF PIPE	LEAKAGE (GALLONS PER 24 HOURS PER INCH OF DIAMETER PER MILE OF PIPE)
Ductile iron	10
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic or fiberglass with solvent-cemented joints, or centrifugally cast fiberglass pipe and fittings	0
Concrete with steel and rubber joints	10
Steel with welded joints	0
Steel with harnessed joints	10
Wrought steel	0
Copper	0
All piping inside structures	0

- E. Regardless of the above allowable leakage, any visible leaks detected to be permanently stopped.

3.10 TESTING OF PLUMBING SYSTEMS

- A. Potable Water Lines: Hydrostatically test at 100 psig; maintain pressure for one hour; no leaks allowed.

- B. Test vertical soil and waste vents as soon as set. Plug outlets, fill to top of vertical lines, and hold for 24 hours. Make final test after roughing in is complete and before connecting sewer.
- C. Perform smoke test on drain, waste and vent (DWV) lines in accordance with the following:
 - 1. Perform smoke test on DWV lines after all fixtures have been permanently connected and all traps filled with water.
 - 2. Close all windows and doors in the building and turn HVAC system off for the duration of the smoke test.
 - 3. One or more smoke machines to be connected to main building clean out or other suitable connection. Smoke machines to produce a thick penetrating smoke. Smoke produced by chemical mixtures are not acceptable.
 - 4. Add smoke to the system until smoke is visible at vent stacks. Plug vent stacks and continue to add smoke until a pressure of 1-inch water column is produced. Maintain pressure for a minimum of 15 minutes.
 - 5. Visually inspect each connection and fixture for smoke. Any odor or sign of smoke is indication of system failure.
 - 6. Repair all leaks and retest.

3.11 SPECIAL TESTING PROCEDURES

A. Chlorine Gas Piping Systems

- 1. Clean all portions of the chlorine gas system with a chlorinated solvent such as trichloroethylene. Hydrocarbons or alcohols are not allowed. Cleaning may be accomplished by pulling a cloth saturated with solvent through each length of pipe.
- 2. Hydrostatically test the system at 300 psig for two hours.
- 3. Drying: Chlorine gas lines are to be dried prior to introducing gas into the system. Drying to be accomplished by passing steam through the line until all lines are thoroughly heated. While steaming, allow condensate and foreign matter to drain out. Disconnect the steam supply and drain all low spots. While the line is still warm dry air (air with a dew point of -40°F or less) is to be blown through the line until dry. Air drying may take several hours.
- 4. Gas Testing: After the system is dry, pressurize the system to 150 psig with dry air (-40°F) or nitrogen and test for leaks at joints using soapy water. After testing all joints hold pressure for 30 minutes.
- 5. Introduce chlorine gas gradually into system and test for leaks at all joints using ammonia water solution.

B. LPG or Natural Gas Piping Systems

- 1. After piping installation is complete, but before installation of gas cocks, test the piping system with LP-gas or air at a pressure of 15 psig for 30 minutes. The source of pressure is to be disconnected from the system and there is to be no loss of pressure on the gauge during the test period.
- 2. After installation of gas cocks, test the system again with air or LP-gas at 5 psig for 15 minutes. Gas source is to be disconnected and no loss of pressure allowed.

3. If appliances are installed at the same time as the piping system, a final pressure test (including appliance valves) is to be made. The system is to be tested at not more than 14" water column and not less than 10" water column for a period of 15 minutes without a drop in pressure.
4. During testing, the piping system is to remain at a constant temperature so that a rise in temperature with a resultant rise in pressure does not mask small leaks.

C. Air Piping Systems

1. Depending on the size of the piping, the system is to be hydrostatically tested or tested with high pressure air. In general, all piping larger than 2" in size is to be hydrostatically tested. Piping 2" and smaller may be hydrostatically tested or high pressure air tested (CONTRACTOR's Option).
2. High pressure air systems (systems with a working pressure greater than 15 psig) are to receive a 24-hour stand pressure time test. Test pressure to be 150% of system working pressure, but not less than 150 psig. System to hold pressure for 24-hours with a loss of no greater than 5 psig.
3. Low pressure air systems (systems with a working pressure less than 15 psig) are to receive a 2-hour stand pressure time test at 25 psig. No pressure loss allowed.

D. Vacuum Piping: Test and purge system in accordance with NFPA 56F.

E. Oil and Fuel Lines: Purge lines and hydrostatically or high pressure air test (depending on pipe size) at the specified pressure. No leaks will be allowed. After testing is completed, purge lines with nitrogen or carbon dioxide before admitting product.

3.12 TESTING PROCEDURES AT INTERFACES WITH EXISTING PIPING OR BOUNDARIES

A. New Piping That Connects to Existing Piping

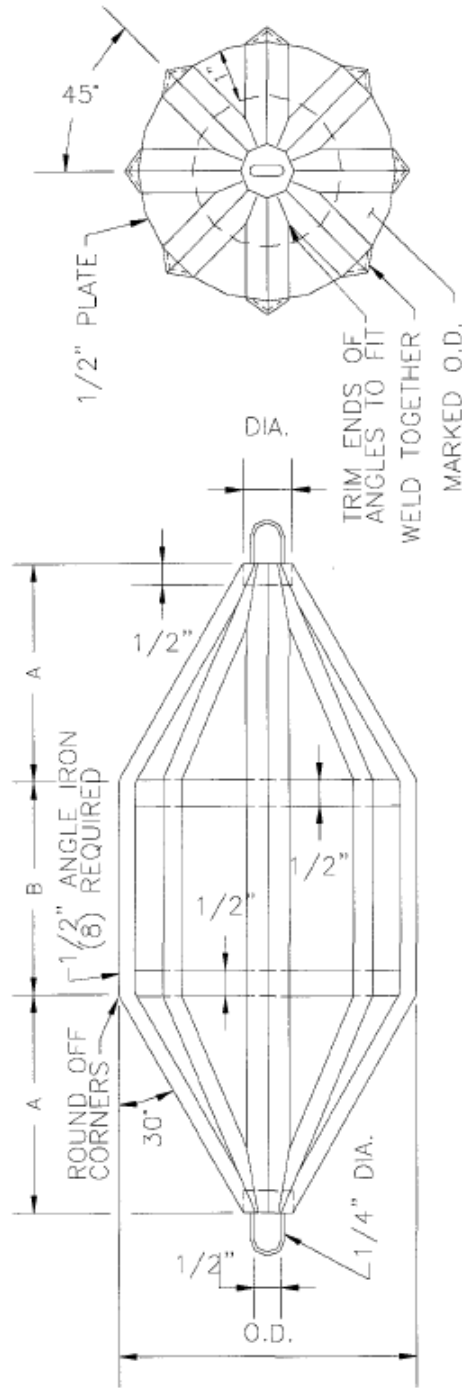
1. Complete piping up to final closure between existing and new piping.
2. Test new piping per applicable paragraph of this Specification by installing a closure piece to isolate the new section. Test pressure as specified or noted.
3. Complete connection to existing piping. If underground, leave joint exposed.
4. Test piping again, per applicable paragraph of this Specification, to verify the integrity of the completed joint.
 - a. Isolate existing piping by installing test plugs or closing valves if they exist. Only isolate piping necessary to verify joint integrity. Test pressure at the interface between new and existing piping to be 110% of the working pressure at the interface. Hold test pressure for one hour. If pressure test fails, maintain pressure at the joint by adding water to the system and visually inspect joint for leaks. If no leaks are visible at the interface, no further testing is required. If leaks are visible, repair and retest.
 - b. Only when noted on PLANS or specified elsewhere, place piping in service and visually inspect joint(s). If no leaks are visible at the interface, no further testing is required. If leaks are visible, repair and retest.
5. Coordination with plant operations is required for removing line from service, closing valves and shutdowns.

B. Pipe Testing at the Boundary between Two Construction Contracts

1. If Connecting Pipe Has Not Been Installed:

- a. Install closure piece (Le. plug, blind flange, etc.) at the boundary and test per applicable paragraph of this Specification. Test pressure to be as specified.
2. If Pipe at Boundary Is Installed:
 - a. Complete piping up to final closure at the boundary.
 - b. Test new piping per applicable paragraph of this Specification by installing a closure piece to isolate the new section. Test pressure as specified.
 - c. Complete connection at boundary. If underground, leave joint exposed.
 - d. Retest piping. Test pressure to be 100% of the working pressure at the boundary. If there are no visible leaks at the interface, then no further testing is required. If leaks are visible at the interface, repair and retest.
3. Installed piping at the boundary between two construction contracts is defined as piping that has been installed and tested per Contract requirements and approved by the ENGINEER.

ATTACHMENT A



END VIEW

SIDE or TOP VIEW

PIPE SIZE (IN.)	A (IN.)	B (IN.)	MANDREL O.D. PVC (SDR-35) ASTM F679 (IN.)	DIA. (IN.)
18	12	12	16.75	2.89
21	14	14	19.74	3.57
24	16	16	22.21	3.73
27	18	18	25.03	4.25

PIPE SIZE (IN.)	A (IN.)	B (IN.)	MANDREL O.D. PVC (SDR-35) ASTM D3034 (IN.)	DIA. (IN.)
6	4.0	4	5.62	1.00
8	5.3	6	7.52	1.40
10	6.7	6	9.41	1.67
12	8.0	8	11.19	1.95
15	10.0	9	13.70	2.15

DEFLECTION TESTING MANDREL

SCALE: NTS

ATTACHMENT B

SERVICE	SIZE	REQUIRED TEST	TEST PRESSURE	DURATION	REMARKS
Gravity					
A. Storm Sewer	All	Visual	None	N/A	
B. Sanitary Sewer	All	(Exfiltration or Infiltration or Low Pressure Air) + TV + Mandrel	See Text	See Text	
C. Surcharged	All	Hydrostatic	150% of system pressure	2 Hrs. (min)	
D. Plant Relief/Drain Line	60"	Exfiltration or Infiltration or Low Pressure Air	See Text	See Text	
E. Lift Station Interconnect Tunnel	60"	Exfiltration or Infiltration or Low Pressure Air	See Text	See Text	
Above Ground					
A. Pump Suction	All	Hydrostatic & Leakage	150% of max. wet well level (25 psi min.)	1 Hr. (min)	No leaks allowed
B. Pump Discharge	All	Hydrostatic & Leakage	150% of pump shut-off head (100 psi min.)	2 Hrs. (min)	
C. All Others	All	Hydrostatic & Leakage	150% of system pressure (100 psi min.)	2 Hrs. (min)	
Underground Pressure Piping	All	Hydrostatic & Leakage	Waterlines: 150 psi Pump discharge: 150% of pump shut-off head (100 psi min.)	2 Hrs. (min)	
Plumbing (Inside Building)					
A. DWV	All	Low Pressure air or hydrostatic smoke	5 psi See Text	24 Hrs. See Text	No leaks allowed
B. Waterlines	All	Hydrostatic & Leakage	100 psi	See Text	No leaks allowed
Tank & Fill Drain	All	Hydrostatic & Leakage	150% of tank head	2 Hrs. (min)	No leaks allowed
Open-Ended Piping	Up to 48"	Hydrostatic & Leakage	25 psi If > 48", consult ENGINEER	1 Hr. (min)	

Gas Piping					
A. Low Pressure Air	Up to 2" > 2"	High Pressure Air Hydrostatic	25psi	2 Hrs. (min)	No leaks allowed
B. High Pressure Air	Up to 2" > 2"	High Pressure Air Hydrostatic	150% of system pressure (150 psi min.)	24 Hrs.	
C. vacuum	All	High Pressure Air	25 psi	2 Hrs. (min)	No leaks allowed
D. All Others	Up to 2" > 2"	High Pressure Air Hydrostatic	See Text	See Text	No leaks allowed

END OF SECTION

SECTION 05050
ANCHORAGE AND FASTENERS

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers the anchorage, fasteners, and erection bolts used in Division 5 and Division 11 Equipment.

1.02 GENERAL REQUIREMENTS

- B. Anchorage and erection bolting shall be designed and selected by the process equipment manufacturers but shall not be less than the sizes indicated in this section, or shown on the plans.

PART 2 - PRODUCTS

2.01 ANCHORAGE

- A. All cast-in-place anchorage shall be minimum 5/8" diameter and shall be of A.L.S.I. Type 316L stainless steel. Submerged anchorage for stainless steel fabrication shall be Type 316L stainless steel.
- B. All submerged and non-submerged anchorage, not cast-in-place, shall be the drop- in type as manufactured by the Molly Division of USM Corporation, or equal. The minimum size drop in style anchor bolt used shall be 1/2" in diameter. Anchors shall be 316L stainless steel.

2.02 ERECTION BOLTS

- A. All assembly bolts for fabricated equipment and metals shall be minimum 3/8 inch in diameter. No field welding will be allowed for assembly of any of the equipment without approval of the Engineer.
- B. Materials
 - 1. All submerged erection bolts shall be of Type 316L stainless steel. For galvanized or painted fabrication, Type 316L stainless steel for stainless steel fabrication.
 - 2. All exposed erection bolts and fasteners attaching to stainless

steel items shall be Type 316L Stainless steel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Cast-in-place anchor bolts shall be cleaned, re-tapped and oiled as necessary prior to use.
- B. Stainless steel anchor bolts and erection bolts shall be coated with an anti-seize compound prior to use.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED CONCRETE ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the furnishing and installation of pre-engineered post-installed concrete anchors to fasten aluminum or stainless steel water treatment plant and other environmental structures as indicated on the PLANS.

1.02 RELATED SECTIONS

- A. Section 11 92 50 High Density Cross-Linked Polyethylene Double Wall Chemical Storage Tank
- B. 22 13 00 Chemical Feed Piping Valves and Fittings

1.03 REFERENCES

- A. The publications listed below form a part of the Specification Section to the extent referenced. The publications are referred in the text by basic designation only.
1. American Society of Testing and Materials (ASTM International)
 2. Concrete Reinforcing Steel Institute (CRSI)
 - a. CTN-M-3-11: Suggested General Drawing Notes for Adhesive Anchors
 3. Concrete Anchor Manufacturers Association (CAMA)
 - a. Special Inspection Guidelines for Post-Installed Anchors
 4. American Concrete Institute (ACI)
 - a. ACI 318 Appendix D, of latest edition.
 - b. ACI-CRSI CP80-12 Installer Workbook: Certification Program for Adhesive Anchor Installer.
 - c. Adhesive Anchors: ACI 355.4 "Qualification of Post-Installed Adhesive Anchors in Concrete." Of latest edition.
 - d. Mechanical Anchors: ACI 355.2 "Qualifications of Post-Installed Mechanical Anchors in Concrete." of latest edition.
 5. American Iron and Steel Institute (AISI)
 - a. AISI Type 316 Stainless Steel
 6. American Water Works Association (AWWA)
 7. National Sanitation Foundation (NSF)
 8. American Society of Plumbing Engineers (ASPE)
 - a. Plumbing Components and Equipment
 9. Occupational Safety and Health Administration (OSHA)
 - a. Standard 1910.23, Subpart D Walking-Working Surfaces
 10. The American Society of Civil Engineers (ASCE)
 - a. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures, of latest edition.
 11. Structural Engineering Institute (SEI)
 12. American National Standards Institute (ANSI)

- a. ANSI A 1264.1 Safety Requirements for Workplace Floor and Wall Openings, Stairs, and Railing Systems
- 13. National Fire Protection Association (NFPA)
 - a. NFPA 101 Life Safety Code
- 14. International Code Council (ICC)/ International Building Code (IBC)
- 15. American Concrete Institute (ACI)

1.04 GENERAL REQUIREMENTS

- A. All materials furnished must be approved for contact with potable water ANSI/NSF 61. This includes any anchors and anchor adhesives.
- B. Furnish all work, labor, materials, equipment, and qualified supervision necessary to engineer, provide, and install ASTM F593 AISI Type 316 anchors in previously poured concrete as specified herein or as otherwise required to anchor or support stairs and guardrails from structure.
- C. Post-installed concrete anchors must be approved by ICC-ES to have met the latest edition of the IBC and ACI 318 Appendix D requirements.
- D. Owner will hire a testing agency qualified to ASTM E329 to provide Special Inspections as governed by the adopted local ICC IBC and anchor load testing per ASTM E488. Contractor to assemble and submit a full installation inspection report.
- E. ICC Evaluations Services Report for concrete anchor manufacturers. Anchor compliance with ICC-ES AC193 and/or ICC-ES AC308 as applicable.
- F. Latest edition of documents referenced in these specifications shall become part of this specification as if written herein. Whenever requirements conflict, the more stringent shall govern.

1.05 SUBMITTALS

- A. Submittal Approval by the Owner's Engineer is cursory and does not relieve the Contractor and the delegated design Engineer from responsibility and requirement to fully comply with the Specifications herein. Submit the following:
 - 1. ICC-ES Evaluation Service Report with a cover letter for all anchors that will be considered for use on this project.
 - 2. Product Data: Anchor manufacturer's data sheets on each anchor type used, including:
 - a. Structural design criteria.
 - b. Product specifications with recommended design values and physical characteristics for epoxy dowels and expansion anchors.
 - c. Samples of representative length and diameter for each type of anchor shown on the design drawings/submittal.
 - d. Quality Assurance Submittals:
 - 1) Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
 - 2) Certificates: ICC ES Evaluation Reports.
 - e. Preparation instruction and recommendations.
 - f. Manufacturer's installation instructions.
 - g. Storage and handling requirements and recommendations.

- h. Installation Qualifications and Procedures: Submit installer ACI certificates and qualifications as required by these specifications. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
- 3. Preliminary proposals for substitutions to specified anchors must be submitted to the Owner's Engineer in a timely fashion so that the project is not delayed.
 - a. The Engineer may reject proposed substitutions for aesthetics, interference, inappropriate materials, fire ratings, non-conformance to specifications, or any other reasons.
- 4. Stamped Calculations shall be submitted for all anchors and anchor groups to be used in this project.
- 5. Engineer's Certificate of Design Conformance with these specifications.
- 6. Mill reports showing anchor material conformance with specifications.
- 7. Closeout submittals: Record Drawings showing exact location of all installed anchors, actual embedment and type of anchor installed with field logs.

1.06 QUALITY ASSURANCE

- A. Field measurements of existing field conditions shall be indicated on shop drawings prior to submittal to ENGINEER for review.
- B. All railing and accessories are to be designed by a qualified Texas licensed engineer and furnished by the same manufacturer.
- C. Contractor to demonstrate railing system and anchor installation training. Anchor Installer must be a certified ACI-CRSI Adhesive Anchor Installer.
- D. Contractor to keep installation inspection logs and documentation showing compliance with installation requirements.
- E. ICC Evaluations Services Report for concrete anchor manufacturers on all anchor types used on this project.
- F. Install all Post-Installed Anchors in strict accordance with the anchor manufacturer's published installation instructions (MPII).
- G. Installer Qualification: Adhesive Anchor Installer must be a certified ACI-CRSI Adhesive Anchor Installer. Additionally:
 - 1. Drilled-in anchors shall be installed by a contractor with at least three years of experience performing similar installations.
 - 2. Installer Training: Conduct a thorough training with the manufacturer of the manufacturer's representative for the contractor of the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
 - a. Hole drilling procedure
 - b. Hole preparation and cleaning technique
 - c. Adhesive injection technique and dispenser training/maintenance
 - d. Proof loading/torqueing
- H. Anchor installation shall comply with Concrete Anchor Manufacturers Association (CAMA): Special Inspection Guidelines for Post-Installed Anchors.

- I. Special Inspections and Tests in accordance with ACI and IBC 2012, Chapter 17. Testing Agency shall meet the requirements of ASTM E 329. Special Inspections shall be in accordance with a current published ICC-ES Evaluation Report. Testing Agency will be provided by the Owner.
- J. Cutoff anchors will not be accepted.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver anchors and accessories to jobsite storage area with sufficient protection to ensure undamaged condition.

1.08 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work for the furnishing and the installation of anchors as specified within this Section. Include cost in Contract bid for work of which this is a component part.

PART 2 - PRODUCTS

2.01 MANUFACTURER(S)

- A. Subject to compliance with requirements, provide products by the following manufacturer or Equal:
 - 1. Hilti, Inc.
 - 2. Or Approved Equal.
 - a. It is the Contractor's responsibility to provide sufficient documentation so that the Engineer may determine if the submitted product meets or exceeds the specified product(s). If sufficient documentation is not provided, or if the product does not meet or exceed the specified product characteristics and quality, then the submitted product will be rejected.

2.02 MATERIALS

- A. All material rated for exterior installation.
- B. Expansion Anchors and Adhesive Anchors:
 - 1. ½ inch minimum diameter ASTM F593, AISI Type 316
- C. Anchor Nuts:
 - 1. ASTM F594.
- D. Avoid installing stainless steel anchors and nuts directly in contact with dissimilar metals to prevent galvanic corrosion.
- E. Concrete post-installed anchors for securing stairs and railings:
 - 1. Type 316 Stainless Steel minimum ½ inch diameter. Use ICC IBC and ACI approved values for size, length, embedment, spacing, and edge distance to meet required loads. Include provisions to prevent galvanic corrosion due to dissimilar metal contact. All anchors shall have an ICC ES Evaluation Report indicating conformance with current applicable ICC IS Acceptance Criteria. Anchors subject to testing per ASTM E488 and Special Inspections.
- F. Adhesive:

1. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments, with gray color after mixing. Approved for contact with potable water ANSI/NSF 61.
2. Cure temperature, pot life, and workability: Compatible for intended use and environmental conditions.
3. Nonsag, with selected viscosity based on installation temperature and overhead application where applicable.
4. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
5. Cartridge marking: Include manufacturer's name, product name, material type, batch serial number, and adhesive expiration date.

2.03 DESIGN AND FABRICATION

- A. Engage a qualified Texas licensed professional engineer to design all anchors required to secure proposed equipment and structures to existing concrete structure. Anchorage system shall be ASTM F593 AISI Type 316 adhesive or mechanical for exterior environments in cracked concrete as appropriate and in compliance with ICC IBC and ACI 318 Appendix D of latest edition. Anchors shall be a minimum of ½ inch in diameter at the embedment and edge spacing prescribed by the codes, standards, and guidelines included in these specifications considering all applicable load combinations including wind and seismic criteria. Special inspections by an ASTM E329 agency will be required for the post-installed anchorage system in accordance with ACI and ICC IBC 2012, Chapter 17. All anchors shall have an ICC ES Evaluation Report indicating conformance with current applicable ICC IS Acceptance Criteria, indicating the anchor is approved for installation in cracked concrete as required by ACI 355.4 and/or ACI 355.2 as applicable. Whenever requirements conflict, the more stringent shall govern. The structural adequacy of the anchorage design is the responsibility of the delegated design Engineer.
- B. Design anchors to withstand the required loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each anchor of the respective components of the fastened equipment and structures.
- C. Concrete anchors for fastening equipment and structures to existing environmental concrete structure: Anchors with a strength required by calculations with concrete strength assumed at 2,500 psi.
 1. Concrete anchors in accordance with locally adopted ICC IBC for size, length, embedment, spacing, and edge distance to satisfy design with a safety factor of 4. No less than 5 hole diameters from edge and no less than 2.5 in from edge.
- D. Galvanic Corrosion:
 1. Design anchorage of stainless steel to aluminum stairs and guardrails with provisions to prevent galvanic corrosion while maintaining the structural integrity and durability of the installation.

2.04 SOURCE QUALITY CONTROL

- A. All anchorage and accessories are to be specified by a qualified Texas licensed engineer and furnished by the same manufacturer.
- B. Special Inspections as governed by the adopted local ICC IBC.
- C. All post-installed anchors in concrete shall have current published ICC-ES Evaluation Report indicating the anchor is approved for installation in cracked concrete as required by ACI 355.4. Only approved for this installation shall be used.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

- A. All post-installed anchors in concrete shall have current published ICC-ES Evaluation Report indicating the anchor is approved for installation in cracked concrete as required by ACI 355.4. Only approved for this installation shall be used.
- B. Installer Qualification: Adhesive Anchor Installer must be a certified ACI-CRSI Adhesive Anchor Installer. Additionally:
 - 1. Drilled-in anchors shall be installed by a contractor with at least three years of experience performing similar installations.
 - 2. Installer Training: Conduct a thorough training with the manufacturer of the manufacturer's representative for the contractor of the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
 - a. Hole drilling procedure
 - b. Hole preparation and cleaning technique
 - c. Adhesive injection technique and dispenser training/maintenance
 - d. Proof loading/torqueing
- C. Anchor installation shall comply with Concrete Anchor Manufacturers Association (CAMA): Special Inspection Guidelines for Post-Installed Anchors.
- D. Special Inspections and Tests in accordance with ACI and IBC 2012, Chapter 17. Testing Agency shall meet the requirements of ASTM E 329. Special Inspections shall be in accordance with a current published ICC-ES Evaluation Report. Testing Agency will be provided by the Owner.
- E. Cutoff anchors will not be accepted.
- F. Identify location of embedded items such as reinforcing steel, stressing tendons, conduit, etc. prior to drilling holes. Use specialized equipment to trace electrical wiring and field spot before drilling. Coordinate with respective trades if any apparent conflicts exist. Exercise care in coring and drilling to prevent injuries and avoid damaging any existing embedded items. If embedded items are encountered, stop drilling and contact the Owner's Field Coordinator and/or Engineer immediately. Any offsets or relocations of anchors must be approved by the Engineer in advance. The contractor is responsible for the cost of any required repairs including engineering costs. A Contractor Job Safety Analysis must be submitted prior to drilling or coring. The safety of the Contractor operatives is the sole responsibility of the Contractor.

- G. Install all Post-Installed Anchors in strict accordance with the anchor manufacturer's published installation instructions (MPII).
- H. Drill holes of proper diameter and depth in accordance with manufacturer's published design information for that specific anchor. Use only equipment and procedures approved by the anchor manufacturer for anchor installation. All holes shall be perpendicular to the concrete surface unless shown otherwise on the structural design plans.
- I. Clean out holes, properly prepare substrate, and install anchors in accordance with manufacturer's instructions. Proper tools must be on the job site.
- J. Contractor to keep a log of all installed anchor embedment and location, to be supplied with asbuilts.
- K. Expansion Anchors: Set anchors to manufacturer's recommended torque, using torque wrench.
- L. Adhesive Anchors: Must meet ANSI/NSF 61. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by the anchor adhesive manufacturer. Verify that base material temperature is within manufacturer limits. Do not install adhesive anchors if any criteria do not fall within the manufacturer's recommended limits. Ensure that bore holes and anchors are free of dust, standing water, ice, debris, grease, oil, dirt and other foreign matter.
- M. Remove and replace misplaced or unacceptable anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as unacceptable.

3.02 FIELD QUALITY CONTROL

- A. Unless otherwise directed by the Owner, all post-installed anchors shall be inspected and tested in accordance with applicable codes and standards but not less than the following schedule:
 - 1. All down hole, non-adhesive anchors: 25% of each type of anchor.
 - 2. All adhesive anchors: 40% of each type of anchor.
 - 3. All anchor types supporting sustained loads and all overhead anchors: 100% of each type of anchor.
- B. Inspect all anchor types to assure proper materials are utilized as shown on Contract PLANS and submitted sealed design drawings. Post-installed anchor installation shall be completed per the MPII and the requirements of this specification.
- C. Testing: Each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors shall not be torqued tested.
 - 1. Tension testing shall be performed in accordance with ASTM E488 and any other applicable codes.
 - 2. Torque shall be applied with a calibrated torque wrench.
- D. Protect material from damage both before and during installation.
- E. Installation of equipment and structures to be as shown on PLANS, per equipment manufacturer's recommendations, and per delegated engineered design.

- F. Installation and field drilled holes for bolts to be per manufacturer's recommendations.
- G. Obtain approval from delegated design Engineer and from the Engineer of Record/Owner through RFI prior to creating adjustments not scheduled.
- H. Tolerances: Maximum variation from plumb shall be no more than ¼ inch per story, non-cumulative. Maximum offset from true alignment shall be ¼ inch.
- I. Install pipe supports plumb and aligned to within 1/8 inch in 12 feet. Shims, wedges, grout, and similar devices or methods for post alignment not permitted.
- J. Provide asbuilts and anchor installation logs reviewed by and certified by the delegated design Engineer to conform to the design requirements.
- K. Remove debris, containers and excess material resulting from work specified herein.

END OF SECTION

SECTION 07902
SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section describes the installation and material requirements for sealants at joints and around doors, windows, floor and wall penetrations that leave an open joint.
- B. The work included in this Section includes the furnishing of all labor material, tools, equipment, and services necessary for, and reasonably incidental to, the execution of caulking and sealant work. The work includes the following type of sealants:
 - 1. Single-component non-sag polyurethane
 - 2. Two-component self-leveling polyurethane
 - 3. Two-component, non-sag polyurethane
 - 4. Silicone joint sealers
 - a. Single component, non-acid curing, silicone
 - b. Single component, mildew resistant, silicone
 - 5. Acrylic-emulsion sealants
 - 6. Fire resistant joint sealer
 - 7. Backer rod

1.02 RELATED REQUIREMENTS

- A. Surface preparation, painting and coating requirements are specified in Section 09902, "Painting and Protective Coatings".
- B. Related work as called for on PLANS, or in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. American Society For Testing And Materials (ASTM)
 - a. C790, Standard Guide for the Use of Latex Sealants
 - b. C834, Standard Specification for Latex Sealants
 - c. C920, Standard Specification for Elastomeric Joint Sealants
 - d. C962, Standard Guide for the Use of Elastomeric Joint Sealants
 - e. E814, Standard Test Method for Fire Tests of Through Penetration Fire Stops
 - 2. Federal Specifications (FS)
 - a. TT-S-00230C, Federal Specification for Single-Component Joint Sealants
 - b. TT-S-00227E, Federal Specification for Two-Component Joint Sealants

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, "Submittals".
 - 1. Product Data: Manufacturer's technical product data and installation instructions for each type of sealant used.

2. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.

1.05 QUALITY ASSURANCE

- A. Use only qualified workmen thoroughly skilled and specially trained in the techniques of caulking, who can demonstrate their ability to fill joints solidly and neatly.
- B. Mixing and application of sealing compounds is to be in strict accordance with the manufacturer's printed instructions.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver joint sealer materials in original, unopened, unbroken, sealed containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.
- C. Store in original containers in a cool and dry location on level supports and protect materials from damage and exposure to the elements until installed. Do not keep in storage for over 90 days.

1.07 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

PART 2 - PRODUCTS

2.01 MANUFACTURER(S)

- A. Subject to compliance with the requirements of this Section, provide one of the following.
- B. Single-Component Non-Sag Polyurethane
 1. "Sonolastic NP I", by Sonneborn Contech
 2. "Sikaflex-1a", by Sika Chemical Corporation
 3. "Dymonic", by Tremco
- C. Two-Component Self-Leveling Polyurethane
 1. "Sonolastic SL II", by Sonneborn Contech
 2. "Sikaflex-2C SL", by Sika Chemical Corporation
 3. "Tremco THC-900", by Tremco
- D. Two-Component Non-Sag Polyurethane
 1. "Sonolastic NP II", by Sonneborn Contech
 2. "Sikaflex-2C NS", by Sika Chemical Corporation
 3. "Dymeric", by Tremco
- E. Silicone Joint Sealers
 1. One-Part, Nonacid-Curing, Silicone Sealant
 - a. "Dow Corning 790", Dow Corning Corp.
 - b. "Dow Corning 795", Dow Corning Corp.

- c. "Silglaze N SCS 2501", General Electric Co.
- d. "Silpruf SCS 2000", General Electric Co.
- e. "Spectrum 1", Tremco, Inc.
- f. "Spectrum 2", Tremco, Inc.
- g. "OmniSeal", Sonneborn Building Products Div.
- h. "Gesil N SCS 2600", General Electric Co.
- 2. One-Part, Mildew-Resistant, Silicone Sealant
 - a. "Dow Corning 786", Dow Corning Corp.
 - b. "SCS 1702 Sanitary", General Electric Co.
 - c. "Proglaze White", Tremco Corp.
 - d. "OmniPlus", Sonneborn Building Products Div.
- F. Acrylic-Emulsion Sealants
 - 1. "Chem-Calk 600", Bostik Construction Products Div.
 - 2. "Sonolac", Sonneborn Building Products Div.
 - 3. "Tremflex 834", Tremco, Inc.
- G. Fire-Resistant Joint Sealers
 - 1. "Dow Corning Fire Stop Foam", Dow Corning Corp.
 - 2. "Pensil 851 ", General Electric Co.
- H. Foam Backer Rod
 - 1. "Sonofoam", by Sonneborn Contech
 - 2. "Ethafom SB", by Dow Chemical

2.02 MATERIALS AND/OR EQUIPMENT

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the OWNER from manufacturer's standard colors.
- C. Single-Component Non-Sag Polyurethane: Single-component, self-priming, gun-grade, fast skinning, fast curing, 100% urethane base sealant conforming to Federal Specification TT-S-00230C, Class A, Type II, and ASTM C920, Class 25, Type S, Grade NS.
- D. Two-Component Self-Leveling Polyurethane: Two-component, self-leveling, abrasion and puncture resistant urethane sealant conforming to Federal Specification TT-S-00227E and ASTM C920.
- E. TWO-Component Non-Sag Polyurethane: Multi-component epoxidized polyurethane designed for adhesion, long service life, and durability of dynamically moving building joints and horizontal joints conforming to Federal Specification TT-S-00227E, Type II, Class A, and ASTM C920, Type M, Grade NS, Class 25. Movement capability of 40% in extension and 25% in compression for joints up to 2" wide and 0.5" deep.
- F. Silicone Joint Sealers: Provide the following types.
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
- G. Acrylic-Emulsion Sealants: One-part, non-sag, mildew-resistant, paintable complying with ASTM C834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - H. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories to have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
 - I. Backer Rod: Preformed, compressible, resilient, non-waxing, non-extruding, closed-cell, polyethylene foam rods. Minimum 1/8-inch diameter greater than joint width for joints less than 3/4-inch wide. Use 1-inch diameter rod for joints 3/4-inch wide.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Condition: Joint surfaces to receive sealant are to be sound, smooth, clean, dry, and free of all visible contaminants.
- B. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- C. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- D. Joint Backing: In joints where the depth of the joint exceeds the recommended sealant depth, install joint backing to provide support and uniform depth of sealant. Push applicable size backer rod into joint to depth required. Joint backing to be installed with approximately 30% compression. Do not twist, stretch, puncture, or tear backing material. Backing material to butt together at intersections.

3.03 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C962 for use of elastomeric joint sealants.
 2. Comply with recommendations of ASTM C790 for use of acrylic-emulsion joint sealants.
- B. Sealant Depth
1. Joint widths less than 1/4-inch: Provide 1/4-inch sealant depth.
 2. Joint widths over 1/4-inch to 1/2-inch: Provide sealant depth equal to joint width.
 3. Joint widths greater than 1/2-inch: Provide sealant depth equivalent to 1/2 of joint depth.
- C. Application: Apply sealant in continuous line using hand guns or pressurized equipment, with proper nozzle size in accordance with manufacturer's recommendations. Force sealant into joint and against sides of joint to make a uniform bead. Fill sealant spaces completely and avoid pulling sealant from the sides of the joint. Use opened containers the same day.
- D. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- E. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.
- F. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

3.04 CLEANING

- A. Thoroughly clean doors, windows, and surrounding structure of excess sealant compounds or smears upon completion of work with cleaning solvents recommended by sealant manufacturer.
- B. Clean up and remove, periodically, all sealant work debris.
- C. Clean up area completely and thoroughly after completion of work.

3.05 SCHEDULES

- A. General:
 1. Unless otherwise indicated, joints around the perimeter of frames shall be sealed using sealer specified below for the substrate adjacent to the frame.
- B. Expansion and control joints in exterior and interior surfaces of masonry walls:
 1. Single-component non-sag polyurethane; concave joint configuration
 2. Backer rod or bond-breaker tape
- C. Expansion and control joints in exterior and interior surfaces of cast-in-place concrete walls:
 1. Two-component, non-sag polyurethane; concave joint configuration

2. Backer rod or bond-breaker tape
- D. Expansion and control joints in exterior and interior surfaces of cast-in-place concrete slabs:
 1. Two-component self-leveling polyurethane sealant
 2. Backer rod or bond-breaker tape
- E. Interior joints at wet areas (including perimeter of bath fixtures, counter tops, glazed ceramic tile areas):
 1. Single component mildew-resistant silicone sealant; concave joint configuration
 2. Bond-breaker tape where appropriate
- F. Exterior or interior joints and penetrations in fire rated walls and smoke barriers (includes fire-rated walls in chlorine rooms):
 1. Fire resistant joint sealer
 2. Backer rod as required for fire penetrations
- G. Preparation for interior painted surfaces:
 1. Acrylic-emulsion sealant
- H. Interior or exterior joints for which no other sealer is indicated:
 1. Single component, non-acid curing silicon sealant; concave joint configuration
 2. Backer rod or bond-breaker tape

END OF SECTION

SECTION 09901
PAINTS AND COATINGS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Tools, equipment, materials, and supplies and labor required to complete the protective coating of all specified surfaces, including all surface preparation, pretreatment, coating application, touch-up of factory-coated surfaces, protection of surfaces not to be coated, cleanup, and appurtenant work.
- B. The following surfaces shall not be protective coated hereunder unless shown or specified herein or elsewhere in the Contract Documents.
 - 1. Exterior, non-immersed concrete.
 - 2. Stainless steel.
 - 3. Machined surfaces.
 - 4. Grease fittings.
 - 5. Glass.
 - 6. Equipment nameplates.
 - 7. Maintenance hole frames and covers.
 - 8. Platform gratings, stair treads, door thresholds, and other walk surfaces.
- C. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. The Design/Builder shall provide submittals to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

1.02 RELATED WORK (NOT USED)

1.03 REFERENCE SPECIFICATION, CODES AND STANDARDS

- A. ANSI A13: Scheme for Identification of Piping Systems.
- B. ANSI/AWWA C105: Polyethylene Encasement of Ductile Iron Piping for Water and Other Liquids.
- C. ANSI/AWWA C203: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied.
- D. ANSI/AWWA D102: Painting Steel Water-Storage Tanks
- E. TT-P-28F: Paint, Aluminum, Heat Resisting (1200F)

1.04 SUBMITTAL PROCEDURES

- A. Submittals shall be made in accordance with Section 013300.

- B. Samples: The Contractor shall submit samples of all paint, finishes, and other coating materials specified herein, in accordance with the GENERAL REQUIREMENTS. Paint or coating samples shall be submitted on 8-1/2-inch by 11-inch sheet metal. Each sample shall be completely coated over its entire surface with one protective coating material, type, and color.
- C. Coating Materials List: The Contractor shall provide 8 copies of a coating materials list which indicates the manufacturer and the coating number, keyed to the coating systems herein, prior to or at the time of submittal of samples.
- D. Manufacturer's Certification: For submerged and severe service coating systems, the Contractor shall require the paint manufacturer to certify to the following:
1. The manufacturer's representative has provided at least 6 hours of on-site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.
 2. The manufacturer's representative has personally observed the start of surface preparation, mixing, and application of the coating materials. The Contractor shall submit all such certificates to the Engineer within 7 days of completion of each paint system.
- E. Applicator's Certificate and Report: For submerged and severe service coating systems, the Contractor shall require the applicator of the protective paint coatings to certify to the following:
1. Immediately before painting, surfaces conformed to the specified preparation; they were in the specified condition; and were clean, dry, and free of dust, rust, and mill scale.
 2. Surface preparation and coating use, mixing, application, and curing were done in accordance with the current printed instructions and recommendations of the protective coating manufacturer, and these Specifications.
 3. The products specified were used and a listing of the names of the products and their manufacturer.
 4. The products were used within the shelf-life dates, stating the shelf-life dates of each container of each product used.
 5. The specified dry film thickness of coatings are on the items.
 6. The quantities of each product used with copies of paint manufacturer's invoice.
 7. Compatible paints were used where shop or field applied coatings are applied over previously-applied coatings. The applicator's certificate shall list the dates and locations that the coating work was completed for the various surfaces coated, and shall also list the dry film thickness obtained for each coat. The Contractor shall submit said paint applicator's certificates to the Owner's Representative within 7 days after completion of each paint system.

1.05 QUALITY ASSURANCE

- A. Where protective coatings are to be performed by a subcontractor, said subcontractor [must possess a valid state license as required for performance of the painting and coating work called for in this specification and] must provide 5 references which show that the painting subcontractor has previous successful experience with the specified or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the painting subcontractor provided the protective coating.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Definitions: The term "paint", "coatings", or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The term "DFT" means minimum dry film thickness.
- B. The Contractor shall use coating materials suitable for the intended use and recommended by their manufacturer for the intended service.
- C. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, subject to the approval of the Engineer, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.
- D. Protective Coating Materials: Products shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the Contractor shall provide the Engineer with the names of not less than 10 successful applications of the proposed manufacturer's products demonstrating compliance with this specification requirement.
- E. Substitute or "Or-Equal" Submittals: Unless otherwise specified, materials are from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed. The Contractor shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or-equal" material that said material meets the specified requirements and is equivalent or better than the listed materials in the following properties:
1. Quality
 2. Durability
 3. Resistance to abrasion and physical damage
 4. Life expectancy
 5. Ability to recoat in future
 6. Solids content by volume
 7. Dry film thickness per coat
 8. Compatibility with other coatings
 9. Suitability for the intended service
 10. Resistance to chemical attack

11. Temperature limitations in service and during application
12. Type and quality of recommended undercoats and topcoats
13. Ease of application
14. Ease of repairing damaged areas
15. Stability of colors

2.02 INDUSTRIAL COATING SYSTEMS

A. Material Sources: Each of the following manufacturers is capable of supplying many of the industrial coating materials specified herein. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials must be shown to satisfy the material descriptions and to equal or exceed the properties of the listed materials as required in the paragraph entitled "Substitute or `Or-Equal' Submittals" herein.

1. Ameron
2. Carboline Coatings Company
3. Induron
4. Pittsburgh Paints
5. Tnemec Company

B. System 1 – High Solids Epoxy: Primer and finish coat shall be a rust inhibitive two component epoxy coating with a minimum solids content of 70 percent by volume.

If this coating system is to be used on Galvanized Ferrous Metal; provide surface treatment (or approved equal) for the prime coat as per the Coating Manufacturers product data sheet.

1. Prime coat (DFT = 4 mils), Carboguard 890, Tnemec 69 Epoxoline, or equal.
2. Finish coat (one or more, DFT = 4 mils), Carboguard 890, Tnemec 69 Epoxoline, or equal.

C. System 2 -Not Used

D. System 3 -Aluminum Silicone Resin: Aluminum silicone resin material shall be suitable for a service temperature of up to 1,000 degrees F, and shall comply with Federal Specification TT-P-28.

1. Prime coat and finish coat (2 or more, DFT = 3 mils), Rust-Oleum 4315, or equal.
Total system DFT = 3 mils.

E. System 4 -Aliphatic Polyurethane: Two component aliphatic acrylic or polyester polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58 percent by volume. Primer shall be a rust inhibitive two component epoxy coating with a minimum solids content of 70 percent by volume. If this coating system is to be used on Galvanized Ferrous Metal; provide surface treatment (or approved equal) for the prime coat as per the Coating Manufacturers product data sheet.

1. Prime coat (DFT = 4 mils), Carboguard 890, Tnemec 69 Epoxoline, or equal.
2. Finish coat (one or more, DFT = 3 mils), Carboline 133 MC, Tnemec 1074 EnduraShield, or equal.

Total system DFT = 7 mils. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

F. System 5 -Inorganic Zinc/Polyurethane: The inorganic zinc primer shall be a water or solvent based, self-curing, zinc silicate 2-component inorganic coating which contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. The intermediate coat shall be a high-build two component epoxy with a solids content of at least 70 percent by volume. Finish coats shall be a 2-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58 percent by volume.

1. Prime coat (DFT = 3 mil), Tnemec 90-97 Tneme-Zinc, or equal.
 2. Intermediate coat (DFT = 4 mils), Carboline 890, Tnemec 69 Epoxoline, or equal.
 3. Finish coats (one or more, DFT = 3 mils), Tnemec 1074 Endurashield, or equal.
- Total system DFT = 10 mils.

Intermediate coat shall be applied in excess of 4 mils DFT or in more than one coat as necessary to completely cover the inorganic zinc primer and prevent application bubbling of the polyurethane finish coat.

More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

G. System 6 -Inorganic Zinc, Water Based: Water based, self curing, ethyl silicate shall be a two component inorganic coating material that contains at least 85 percent of metallic zinc by weight in the dried film.

1. Prime coat and finish coat (one, DFT = 3 mils), Carbozinc 11 WB, or equal. Total system DFT = 3 mils.

H. System 7 -Acrylic Latex: Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35 percent by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.

1. Prime coat (DFT = 2 mils), as recommended by manufacturer.
2. Finish coats (2 or more, DFT = 6 mils), Tnemec 1028 Enduratone, or equal. Total system DFT = 8 mils.

I. System 8 -Not Used

J. System 9 -Not Used

K. System 10 – Acrylic, Concrete: High molecular weight acrylic material shall have a minimum solids content of 35 percent by volume. Prime coat shall be an acrylic filler and sealer for concrete surfaces.

1. Prime coat (Filler/sealer), Tnemec 130 Envirofill, or equal.
2. Finish coats (2 or more, DFT=3 mils), Tnemec 180 Tneme-Crete or equal.

L. System 11- Not Used

2.03 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

- A. System 100- Amine Cured Epoxy: High build, amine cured, straight epoxy resin shall have a solids content of least 80 percent by volume, and shall be suitable for long-term immersion service.
 - 1. Prime coat and finish coats (3 or more, DFT = 16 mils), Tnemec 22 Pota-Pox, or equal.
- B. System 101 – Moisture Cured Polyurethane: High-build, multi-coat polyurethane shall have a solids content of at least 70 percent by volume and shall be suitable for long-term immersion service. Total thickness 13-20 mills DFT.
 - 1. Prime Coat (DFT= 3 mils) Tnemec 1 Omnithane, or equal.
 - 2. Intermediate (DFT = 5-10 mils) Tnemec 446 Permashield MCU, or equal.
 - 3. Topcoat (DFT = 5-10 mils) Tnemec 446 Permashield MCU, or equal.

2.04 SPECIAL COATING SYSTEMS

- A. System 200 -PVC Tape: Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.
- B. System 201 -Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.
- C. System 203 -Epoxy Surfacing: Two-component epoxy floor surfacing shall be formulated to resist many acids, alkalies, and solvents. Material shall be resistant to liquid alum, sodium hydroxide, and 50 percent sulphuric acid. Products shall be as follows, or equal:
 - 1. Tnemec Alternative: Prime coat Tnemec 201 Epoxoprime
 - 2. Intermediate Coat: Tnemec 237 Power-Tread;
 - 3. Finish Coat: Tnemec 280 or 281 Tneme-Glaze.
- D. System 204 -Waterproofing: Two coats of a clear, non-staining, silanemodified-siloxane masonry waterproofing material. The waterproofing system 204 after application shall be provided with not less than a five-year warranty on the performance of the product. Surfaces shall be cleaned with a chemical (approved by waterproofing manufacturer) cleaner and power wash. Surfaces shall be clean and dry before application of waterproofing. Method and rate of application shall be in accordance with manufacturer's published instructions. A manufacturer's representative shall be present during applications if necessary for warranty.
- E. System 205 -Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.
- F. System 206 – Not Used
- G. System 207 -Non-Slip Surfacing: Coating shall have one coat of Tnemec 280 Tneme-Glaze with Series 211 additive or equal. The coating shall be gray in color. Application shall be by means of a roller and not more than 60 sq ft per gallon of non-slip coating shall be applied. Primer shall be as recommended by the coating manufacturer.

H. System 208 -Aluminum Metal Isolation: A wash primer (0.5 mils) shall be applied, followed by one coat of heavy bodied bituminous paint, such as Tnemec 46H-413, or equal (8 mils). Total thickness of system (8.5 mils).

PART 3 - EXECUTION

Coating system schedule- ferrous metals

Coating system schedule, ferrous metal – not galvanized;

Coating System Schedule, Ferrous Metal -Galvanized: Pretreatment coatings, barrier coatings, or washes shall be applied as recommended by the coating manufacturer. All galvanized surfaces except for the following items shall be coated unless coating is required by other Sections: (1) Floor gratings and frames, (2) Handrails, (3) Stair treads, (4) Chain link fencing and appurtenances

COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBERGLASS

Where isolated non-ferrous parts are associated with equipment or piping, the Contractor shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	Surface Prep.	System No.
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPCP1	(4) aliphatic polyurethane
NFM-2	Chlorination room, chlorine storage room.	Solvent cleaned SSPCSP1	(100) amine-cured epoxy
NFM-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPCSP1	(208) aluminum metal isolation
NFM-4	Polyvinyl chloride plastic piping, indoors and outdoors, or in structures, not submerged.	Solvent cleaned SSPCSP1	(7) acrylic latex
NFM-6			

	Item	Surface Prep.	System No.
FM-1	All exposed surfaces indoors, except those included below.	Commercial blast cleaning SSPC-SP6/NACE3	(1) Epoxy
FM-1a	All exposed surfaces outdoors, except those included below.	White metal blast cleaning SSPC-SP5/NACE1	(5) Zinc-rich / polyurethane
FM-2	Surfaces in chlorination room, chlorine storage room.	Commercial blast cleaning SSPC-SP6/NACE3	(100) amine-cured epoxy
FM-3	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in wastewater, including all surfaces lower than 2feet above high water level and all surfaces inside enclosed hydraulic structures (excluding shop-coated valves, couplings, pumps).	SSPC-SP10/NACE2	(101) Polyurethane
FM-5	Surfaces exposed to high temperature (between 150 and 600 degrees F).	SSPC-SP10/NACE2	(6) inorganic zinc water based
FM-6	Surfaces exposed to high temperature (between 600 and 1000 degrees F).	white metal blast cleaning SSPC-SP5/NACE1	(3) aluminum silicone resin
FM-7	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FM-8	Buried pipe couplings, valves, and flanged joints (where piping is not plastic, or tape-coated, or mortar-coated steel), including epoxy-coated surfaces.	As specified by reference specification	(201) polyethylene encasement

FM-9	Exterior surfaces of submerged valves.	White metal blast cleaning SSPC-SP5/NACE1	(100) or (101)
FM-10	All ferrous surfaces of sluice gates, flap gates, and shear gates, including wall thimbles.	White metal blast cleaning SSPC-SP5/NACE1	(106) fusion-bonded epoxy
FM-11	Buried surfaces that are not specified to be coated	White metal blast cleaning SSPC-SP5/NACE1	(103) coal tar epoxy
FM-12	Surfaces of indoor equipment.	Dependent on existing surface condition	(4) aliphatic polyurethane
FMG-2	Surfaces in chlorinator room, chlorine storage room.	Alkaline cleaning SSPCSP1	(100) amine-cured epoxy
FMG-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FMG-4	Surfaces buried or submerged in wastewater.	Alkaline cleaning SSPCSP1 followed by brushoff grade blast cleaning SSPC-SP7/NACE4	(100) amine-cured epoxy
	Item	Surface Prep.	System No.
FMG-1	All exposed surfaces indoors and outdoors, except those below.	Alkaline cleaning SSPCSP1	(4) aliphatic polyurethane
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPCP1	(4) aliphatic polyurethane
NFM-2	Chlorination room, chlorine storage room.	Solvent cleaned SSPCSP1	(100) amine-cured epoxy

NFM-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPCSP1	(208) aluminum metal isolation
NFM-4	Polyvinyl chloride plastic piping, indoors and outdoors, or in structures, not submerged.	Solvent cleaned SSPCSP1	(7) acrylic latex
NFM-6			
C-1	Exposed indoors and outdoors.	SSPC SP-13/NACE 6	(10) acrylic, concrete
C-2	Submerged in wastewater including surfaces up to 2 feet above high water line and down to 2-feet below low water line and all surfaces in an enclosed structure. (Except Headworks)	SSPC SP-13/NACE 6	104) coal tar epoxy, concrete
	Item	Surface Prep	System No.
C-2a	Submerged in wastewater including surfaces up to 2-feet above high water line and down to 2-feet below low water line and all surfaces in an enclosed structure. (Headworks)	Per Manufacturer's Recommendations	Raven 405 High Build Epoxy, Spraywall Polyurethane, or approved equal
C-3	Floor slab, exposure to chemicals.	SSPC SP-13/NACE 6	(203) epoxy surfacing
C-4	Floor slab, non-slip surface.	SSPC SP-13/NACE 6	(207) non-slip surfacing
C-5	Interior surfaces of sewer manholes, including sidewalls, bottom, and metal appurtenances.	SSPC SP-13/NACE 6	(102) Epoxy Mortar
C-6		SSPC SP-13/NACE 6	

CBM-1	Exposed, indoors and outdoors.		Clean and dry	(10) acrylic, concrete
CBM-2	Submerged in wastewater, including all vertical masonry surfaces above waterline.		Clean and dry	(104) coal tar epoxy, concrete
CBM-3	Existing buildings (blower buildings, chlorine building) which may be incorporated into the final project		Clean and dry	(10) Acrylic, concrete

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09902
PAINTINGS AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish and apply, as specified herein, paint and protective coatings to all surfaces, except steel water storage tanks, unless specifically excluded by this Section.

1.02 RELATED REQUIREMENTS

- A. PLANS define special coating requirements.
- B. Related work as called for on PLANS, or in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. Steel Structures Painting Council (SSPC)
 - a. SSPC SP-1, Surface Preparation Specification No. 1 - Solvent Cleaning
 - b. SSPC SP-2, Surface Preparation Specification No.2 - Hand Tool Cleaning
 - c. SSPC SP-3, Surface Preparation Specification No.3 - Power Tool Cleaning
 - d. SSPC SP-5, Surface Preparation Specification NO.5 - White Metal Blast Cleaning
 - e. SSPC SP-6, Surface Preparation Specification NO.6 - Commercial Blast Cleaning
 - f. SSPC SP-7, Surface Preparation Specification No. 7 - Brush-Off Blast Cleaning
 - g. SSPC SP-8, Surface Preparation Specification NO.8 - Pickling
 - h. SSPC SP-10, Surface Preparation Specification NO.10 - Near-White Blast Cleaning
 - 2. National Association Of Corrosion Engineers (NACE)
 - a. NACE No.1, White Metal Blast Cleaning
 - b. NACE NO.2, Near-White Blast Cleaning
 - c. NACE NO.3, Commercial Blast Cleaning
 - d. NACE NO.4, Brush-Off Blast Cleaning

1.04 SYSTEM DESCRIPTION

- A. Surfaces receiving coatings include:
 - 1. Equipment, machinery, and metal surfaces.
 - 2. Interior surfaces, as noted in room finish schedule.
 - 3. Concrete surfaces, including concrete blocks (when noted on PLANS).
 - 4. Threads on field-threaded galvanized pipe and conduit.
 - 5. All cabinet and woodwork. (Stain finish unless otherwise noted.)
 - 6. Interior concrete surfaces of new lift station wet wells.
 - 7. Paint concealed structural steel and steel joists, after erection of deck and before steel is enclosed.
 - 8. Procedures and coating systems specified herein are in addition to shop priming and surface treatment specified in other TECHNICAL SPECIFICATION Sections.

- B. Unless otherwise noted or shown, the following areas or items do not require coating:
 - 1. Non-ferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, stainless steel, chromium plate, and atmospherically exposed weathering steel, except where:
 - a. Required for electrical insulation between dissimilar metals;
 - b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry;
 - c. Color coding of equipment and piping is required.
 - 2. Non-metallic materials such as glass, PVC, porcelain, and fiberglass, except as required for architectural painting or color coding.
 - 3. Pre-finished electrical and architectural items such as motor control centers, switchboards, switchgear, panel boards, transformers, disconnect switches, panel boards, acoustical tile, cabinets, elevators, building louvers, etc., except when color coding of equipment is required.
 - 4. Non-submerged electrical conduits attached to unpainted concrete surfaces.
 - 5. Items specified to be galvanized after fabrication unless specified elsewhere or subject to immersion.
 - 6. Insulated piping except as required for architectural painting or color coding.

1.05 SUBMITTALS

- A. Submit the following in accordance with Specification Section 01300, "Submittals".
- B. Painting Schedule: Submit list indicating major items to be painted, preparation, paint manufacturer, product designation, and dry mil thickness.
- C. Panels
 - 1. Submit panels containing samples of proposed paints and coatings. Include three displays of each kind and color of paint used. Panel to be representative of material to be coated.
 - 2. Mark panels to indicate respective types of surfaces to which several kinds and colors of paint, stain, and coating are applied.
- D. Samples: If requested by OWNER, submit 1/4 pint of each kind of paint or stain proposed for use. Do not deliver materials to site until representative samples (if requested) have been approved.
- E. For all materials, furnish ENGINEER with two sets of manufacturer's printed instructions describing surface preparation procedures and application procedures including environmental limits (temperature and humidity).
- F. List of five similar projects in accordance with Paragraph 1.07 B.1.
- G. Material Safety Data Sheets (MSDS) for all coatings, solvents, sealers, and paints to be utilized.

1.06 QUALITY ASSURANCE

- A. Manufacturer: All paints, sealers, and coatings to be manufactured by those firms listed in Table 2. Products of equal quality by other manufacturers will be considered, subject to review of written submittal that includes product data and a detailed paint and coating schedule.

- B. Workmanship
 - 1. Furnish workers who perform quality work and who are experienced and knowledgeable in the surface preparation and application of high-performance industrial coatings. Submit list of five similar projects which have been prepared and coated by the personnel which the CONTRACTOR proposes to employ for this project.
 - 2. Submit manufacturer's written instructions on cleaning and coating prior to any surface preparation or coating.
- C. Whenever possible, all coatings should be from single manufacturer. Unless otherwise specified, coating materials for a specific surface or piece of equipment are to be from a single manufacturer.
- D. All coatings provided for use on this project in the field or from equipment suppliers will be in compliance with Federal, State, and local laws, regulations and ordinances related to items such as lead, chromate, carcinogens and volatile organic compounds. All coatings in potable water service to be National Sanitation Foundation (NSF) approved for potable water service.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver to site in original, sealed containers with manufacturer's label attached.
- B. Store in a protected area that is heated or cooled to maintain temperature range recommended by manufacturer. Protect all materials from weathering and extreme temperatures.
- C. Waste and any hazardous material remaining at the end of the day to be discarded in accordance with national, state, and local regulations.

1.08 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Coating manufacturers are listed by generic type and service in Table 2 attached to this Section.

2.02 MATERIALS

- A. Tables 1 and 2 in this Section include the paint, protective coatings, and sealers for this project. Furnish all such special materials required for the manufacturer's coating systems whether or not included in the Tables.
- B. Products to comply with Federal, State, and local requirements limiting the emission of volatile organic compounds. The maximum volatile organic content of the combination of coating and thinner is not to exceed the following limits (whichever is less):
 - 1. 3.5 pounds per gallon; or
 - 2. The Federal, State or local limit.

C. Colors

1. OWNER reserves the right to select colors.
2. Submit list of items to be painted and color charts for each type of surface.
3. Formulate with colorants free of lead or lead compounds.
4. Proprietary color identification is for selection purposes only. Any authorized manufacturer may supply matches.

D. Safety Color Codes: Follow OSHA requirements of 29 CFR, Part 1910.144 for "Safety Color Codes for Marking Physical Hazards". The following general requirements are set forth as a guide.

1. Red: Fire protection equipment, danger signs, and fire exit signs. Portable containers of flammable material to be red with yellow band or name of contents stenciled in yellow.
2. Orange: Moving or rotating parts of equipment protected by guards, including shafts and couplings, pulleys, and sprockets. (Do not paint wearing surfaces.)
3. Yellow: Caution signs and all physical hazards, including outside levers and weights on check valves, lower pulley blocks and hooks, sprockets and chains on valve operators, inside of openings adjacent to step or ladders, platforms provided for vertical ladders at transition levels, exposed unguarded edges of pits, platforms and walls Subject to being struck, and any piping or equipment extending into normal operating areas.
4. Green: To designate "Safety" and location of first-aid equipment such as gas masks, first-aid kits, and safety deluge showers.
5. Black and White: To indicate areas that must remain clear, such as areas around first-aid, fire-fighting, and other emergency equipment.

E. Piping Color Coding: The identification of process piping and chemical feed lines is to be accomplished by various colors of paint. Color coding to be by solid color and labels. Labels are to be placed along the pipe at no greater than 5-foot intervals.

1. Wastewater Plant Color Codes:

<u>LETTERING</u>	<u>COLOR OF PIPE</u>
Sludge Line	Brown
Gas Line	Red
Potable Water Line	Blue
Chlorine Line	Yellow
Sewage Line	Grey
Compressed Air Line	Green
Heating Water Lines	Blue w/6" Red Bands Spaced 30" Apart
Power Conduit	Orange

2. Piping containing gas, chlorine or other hazardous materials are to be color coded when exposed, located out of view, or buried.
3. Non-potable water lines are to be painted white and marked with black lettering at maximum 5-foot intervals.

PART 3 - - EXECUTION

3.01 GENERAL

- A. Use one convenient location for storing and mixing of materials and keep fire extinguisher available in this area as long as location is used for such purpose.
- B. Thinners and Solvents: Use only those thinners and solvents specified in paint formulas of paint being used and mix in proportions recommended by paint manufacturer.
- C. Coverage: As recommended by paint manufacturer and sufficient to obtain minimum mil thickness specified. Do not exceed maximum thickness specified by manufacturer, if applicable. After final coat is applied, check with elecometer or Mikrotest dry film thickness gauge.
- D. Drying Time: Between successive coats, allow drying time as specified by paint manufacturer. Do not apply additional coats until previous coat is completed.
- E. Provide adequate ventilation for proper curing. Keep materials sealed when not in use.
- F. Environmental conditions such as temperature and humidity to be within the ranges recommended by the coating manufacturer.
- G. Finish coats to be smooth, free of brush marks, streaks, laps or pile up of paints, and skipped or missed areas. Finished metal surfaces to be free of voids or pinholes in any coat when tested with a low voltage detector.

3.02 PREPARATION

- A. General
 - 1. Perform all preparation and cleaning procedures in strict accordance with paint manufacturer's instructions and as specified for each substrate.
- B. Concrete Surfaces
 - 1. Prior to painting, surfaces to be free of all latent matter, burrs, and fins, using one or more of the following methods.
 - a. Remove oil and grease with detergent and thoroughly rinse with fresh water.
 - b. Abrasive blasting may be used only if machinery or other equipment in vicinity of work is adequately protected. Also, avoid settling of dust or grit on freshly painted surfaces.
 - c. Wash concrete surfaces with 10 percent solution of muriatic acid, then wash clean and free of scale, mortar, dust, moisture, and other foreign matter.
 - d. Repair all honeycomb surface defects by coating cleaned honeycombed area with epoxy bonding agent and filling voids with non-shrink grout leaving a smooth uniform concrete surface.
 - 2. If curing compound is used, it must be removed prior to coating.
- C. Metal Surfaces
 - 1. Clean metal surfaces by abrasive blasting in shop as required by Table I and leave clean, dry, and ready to receive prime coat. Provide moisture separators to effectively remove all oil and free moisture from air supply. Cleanliness of air to be tested by impinging an abrasive-free air stream onto a white cloth for one minute. If oil or moisture is detected, air source to be shut down and corrected.

2. Remove all dust and abrasives from surfaces by brushing or blowing with clean, dry air. Remove abrasive grit around and between joints of connecting members.
3. Perform field abrasive blasting only if required to correct unsatisfactorily cleaned and shop-primed metal and when approved by ENGINEER.
4. Removal of Oil and Grease: Remove oil and grease with a solvent approved by coating manufacturer, or by steam combined with detergent (in accordance with SSPC SP-1). Use of gasoline, kerosene, naphtha, or carbon tetrachloride not permitted.
5. Brushing, Scraping, Grinding, and Chipping: In field work, if abrasive blasting is not possible, scrapers, wire brushes, and other suitable grinding or chipping tools may be used (in accordance with SSPC SP-2 or SP-3) for removal of existing paint coatings prior to repainting, or for cleaning, before applying second coats.
6. Surface to be coated on same day as cleaned and before rust bloom occurs. Surfaces which have been cleaned but which have started to show signs of rust or dirt are to be cleaned again prior to coating at no additional expense to OWNER.
7. All surfaces to be at least 5°F or higher above the dew point and remain this way when blasting, priming, or coating.

D. Galvanized Surfaces

1. Clean surface with mineral spirits to remove oil residue.
2. Dry with a clean cloth.

E. Wood Surfaces

1. Clean soiled surfaces in accordance with coating manufacturer's instructions.
2. Sand to a smooth even surface and then dust off.
3. Apply shellac to all knots, pitch and resinous sapwood before priming coat is applied.
4. Fill nail holes, cracks, open joints and other defects with putty after priming coat has dried. Tint putty to match finish color. Sand smooth after putty dries.
5. Apply priming coats to woodwork as soon as practical after woodwork is delivered.
6. Top and bottom edges of all wood doors to be primed and sealed after fitting and before final hanging.

F. Gypsum Wallboard

1. Fill narrow, shallow cracks and small holes with spackling compound.
2. Rake deep, wide cracks and deep holes.
 - a. Dampen with clean water.
 - b. Fill with thin layers of drywall joint compound
3. Allow repairs to dry.
4. Sand smooth. Do not raise nap of paper on wallboard.

3.03 ERECTION, INSTALLATION AND APPLICATION INSTRUCTIONS

A. General

1. Do not apply initial coating until moisture content of surface is within limitations recommended by paint manufacturer. Test with moisture meter.
2. Slightly vary the color of successive coats.
3. Sand and dust between each coat to remove defects visible from a distance of 5 feet.
4. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

5. Change colors at corner of stop where colors differ between adjoining spaces or rooms and where door frames match wall colors.
6. Do not proceed with field applied painting of shop-coated items until any defective work has been cleaned by sandblasting.

B. Brush Application

1. Brushes: Use first-quality hog hair or suitable synthetic bristle brushes. Use of horsehair bristle brushes not permitted. Keep brushes clean and free from accumulation of dried paint or dirt, and when brushes for oil or varnish base paints are not in use, keep them suspended in raw linseed oil bath. Clean brushes with proper solvent before reuse.
2. Application: Apply in uniform thickness consistent with specified coverage and with sufficient cross-brushing to ensure filling of surface irregularities. Exercise particular care in painting around bolt heads and nuts and in corners and other restricted spaces.

C. Conventional Spray Application: Apply with adjustable air gun equipped with suitable water trap to remove moisture from compressed air, and with paint pot having air driven or mechanical agitator. Adjust width of spray to meet the requirements of the surface being coated with suitable air pressure for the particular type of paint being used. Make frequent checks to ensure correct spreading rate and coating and apply without sags, runs, or "orange peel" effect. Correct all such imperfections. Take special care to cover edges, corners, and bolt heads, without bridging over of paint film.

D. Airless Spray Application: Equipment used for airless spray to be designed for, and capable of handling, the volume and pressures necessary to ensure smooth and proper application. Hoses to be specifically designed for the viscosity of the material being sprayed and be of the non-static, self-grounding type. Tips to be properly sized to ensure complete atomization and the spray pattern is to be continuous and free of all fingering effects.

E. Roller Application: Proper length nap rollers to be used to ensure a smooth application free of runs, sags, roller marks, or air bubbles. Use longer nap for rougher surfaces when specified on PLANS. Phenolic core lambs wool type rollers to be used when polyurethanes, epoxies, or other types activated coatings are applied by roller. Standard type rollers to be used on water based and enamel coatings. Rollers to be of sufficient quality to leave finished surfaces free of lint, roller nap, runs, sags, and other imperfections. Roller is not to exceed 24 inches in length.

F. Metal Surfaces

1. Shop-prime metal surfaces, if required, prior to delivery to job site.
2. After delivery and prior to installation, keep all coated metal surfaces clean and free from corrosion. Clean and touch up or repaint damaged areas with additional primer.
3. After erection or installation of metal work, clean and touch up all rust spots, all places where primer has been rubbed or scraped off, and all bolts and nuts. After previously applied paint has hardened, and when surfaces to receive succeeding coats of paint have been cleaned and dried, apply finish paint in accordance with Tables 1 and 2. Allow 7 days or more, as recommended by coating manufacturer, for curing of final coat for submerged surfaces.

4. Factory-Finished Equipment: After installation of factory-finished machinery and electrical equipment, check base coats carefully and touch up all damaged surface areas. Do not paint nameplates, serial number bases, chrome, or bronze trim. Clean off any excess paint that impairs convenient removal of covers on gauges, instrumentation, or other equipment fitted with doors or covers.
5. Factory-Primed Equipment: Delay final field coating to manufacturer's primed equipment until equipment has been installed and is in proper working order in accordance with the applicable Section.

G. Mixing and Tinting

1. Deliver paints and enamels ready mixed to job site.
2. Accomplish job mixing and job tinting only when acceptable to the ENGINEER.
3. Mix only in mixing pails placed in suitably sized non-ferrous or oxide resistant metal pails.
4. Use tinting colors recommended by manufacturer for the specific type of finish.
5. Multiple-Component Coatings:
 - a. Prepare using all the contents of the container for each component as packaged by the manufacturer.
 - b. No partial batches permitted.
 - c. Do not use multiple component coatings that have been mixed beyond their pot life.
 - d. Provide small quantity kits for touch up painting and for painting small areas.
 - e. Mix only components specified and furnished by coating manufacturer.
 - f. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

H. Special Requirements: Cast iron or ductile iron piping and valves for interior and exterior aboveground installation with a factory-applied bitumastic or asphaltum varnish coating to be cleaned by abrasive blasting to a NACE NO.3 finish for interior installations and a NACE No.2 finish for exterior surfaces. Primer and finish coat to be applied in accordance with Table 1. If primer is not applied within 24 hours, surfaces to be retreated.

3.04 REPAIR/RESTORATION

- A. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.
- B. Remove all masking products used to protect hardware or built-in work.
- C. Final Cleaning and Touch Up
 1. Touch up and restore finish where damaged.
 2. Do not mar surface finish of item being cleaned.
- D. Refinish whole wall where portion of finish has been damaged or is not acceptable.
- E. Damaged Coatings, Pinholes and Holidays
 1. Feather edges and repair in accordance with recommendations of coating manufacturer.
 2. Repair fusion bonded coatings as recommended by original applicator. Applicator to furnish liquid repair kits for this purpose as recommended by the coating manufacturer.

3. Apply finish coats, including touch up and damage-repair coats, in a manner which presents a uniform texture and color-matched appearance.

F. Unsatisfactory Application

1. If coating has improper finish color or insufficient film thickness: Clean and top coat surface with specified material to obtain specified color and coverage. Obtain and follow specific surface preparation information for top coating from coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat in accordance with this Section. Depending on extent of repair and appearance, a finish sanding and top coat may be required.
3. Evidence of runs, sags, bridges, shiners, laps, or other imperfections to be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer.
5. Leave all staging in place until ENGINEER has inspected surface or coating. Replace staging removed prior to inspection and approval by ENGINEER.

3.05 FIELD QUALITY CONTROL

- A. Schedule field operations to avoid settling of dust or grit on freshly painted surfaces, and adequately protect machinery or other equipment in vicinity of abrasive blasting work.
- B. Request review by OWNER of first finished room, space, or item, of each color scheme for color, texture, and workmanship.
- C. Use first acceptable room, space or item (as determined by OWNER), as project standard for each color scheme.
- D. For spray application, paint an area no smaller than 100 square feet as the project standard.

3.06 CLEANING

- A. During the progress of the work, remove from the project site at the close of each day's work, all oily rags, discarded materials, rubbish, cans, and dispose of in accordance with national, state, and local regulations.
- B. On completion of operations, remove all spots, oil, and stain from all surfaces and leave entire project in clean condition as far as this work is concerned.
- C. Remove from premises all containers and debris resulting from this work and dispose of in accordance with Federal, State and local regulations.
- D. Upon completion of the work remove staging and scaffolding from the site.

3.07 TESTING AND INSPECTION

- A. CONTRACTOR is to perform routine quality control testing on each coat to ensure the integrity of the protective coating. At a minimum, the following tests are to be performed.
 1. Dry film thickness.
 2. Holiday testing.
 3. Any additional tests as recommended by coating manufacturer.

- B. Any and all testing performed by the ENGINEER is for the sole purpose of verifying compliance with this specification. CONTRACTOR is not to rely upon testing performed by the ENGINEER as a means of quality control.
- C. CONTRACTOR to provide the following equipment for use by the ENGINEER.
 - 1. One magnetic pull-off type, non-destructive paint film thickness gauge, such as a Mikrotest thickness gauge. Thickness gauge to become OWNER's.
 - 2. One set of certified coating thickness calibration standards produced by the U.S. Department of Commerce. Calibration standards to become OWNER's.
 - 3. One "wet sponge", low voltage, D.C. type holiday detector, such as the TinkerRazor Electrical Holiday Detector.
- D. Provide the ENGINEER with the proper safety equipment for observation and testing of the applied coating.
- E. To facilitate ENGINEER's inspection of coated surfaces, CONTRACTOR to provide scaffolding/rigging and adequate illumination as required to perform the dry film thickness reading and holiday test inspections as required by this specification and the referenced standards. Provide personnel to move the scaffolding, lighting, or rigging at the request of the ENGINEER.
- F. No equipment is to be placed in service until the protective coating has been tested and approved by the ENGINEER.

3.08 PROTECTION

- A. CONTRACTOR is solely and completely responsible for conditions of the job site including safety of all persons (including employees) and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Conform with safety provisions of the U.S. Department of Labor, Occupational Safety and Health Act, any equivalent State law, and all other applicable Federal, State, and local laws, ordinances, and codes.
- B. Protect floors and all other areas where work is done, with suitable drop cloths.
- C. Remove, mask, or otherwise protect all hardware, hardware accessories, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, labels, nameplates, etc. and other surfaces not intended to be painted prior to surface preparation and painting. Reinstall the removed items by workmen skilled in the trades involved.
- D. CONTRACTOR is cautioned of the potential risk of damage and/or nuisance to the adjoining property and/or structures. CONTRACTOR is responsible for providing necessary equipment and/or controls to minimize the carryover of dust, paint, and abrasives. If excessive dust, paint, or abrasives are determined by the OWNER, or their representative, to be affecting adjoining property and/or structures, CONTRACTOR to utilize shrouds, drop tubes, or other means to confine a minimum of 95 percent of the abrasive, paint, and other material to the associated work area.
- E. Protect working parts of mechanical and electrical equipment from damage. Mask openings in motors to prevent paint and other materials from entering motor.

3.09 SCHEDULES

A. Attachments to this Section define System Schedule (Table 1) and Coating Schedule (Table 2).

TABLE 1- SYSTEM SCHEDULE

Type Of Surface	Exposure	Surface Preparation/Cleaning	Table 2- Material Reference			Minimum Total Mils Thickness	
			Primer	1 ST Coat	2 nd Coat		3 rd Coat
Clay Or Brick Masonry	Exterior ⁽¹⁾	Manufacturer's Specification	-----	1			NA
Concrete Block Buildings	Exterior	Manufacturer's Specification	-----	2	4	4	3.0 (Finished Coat)
Concrete Block Walls	Interior ⁽²⁾ - Painted	Paragraph 3.02 B	-----	3	4	4	3.0(Finished Coat)
	Interior ⁽²⁾ - Sealed						NA
Concrete Walls and Ceilings	Interior	Paragraph 3.02 B	-----	3A	4	4	3.0 (Finished Coat)
Wood	Exterior and Interior	Paragraph 3.02 B	10	3	11		4.5
Wood, Clear Finish, Satin	Interior	Manufacturer's Specification	23,24	11	26	26	4.0
Wood, Clear Finish, Gloss	Interior	Manufacturer's Specification	23,24	25	27	27	4.0
Wallboard (Semi-Gloss)	Interior	Manufacturer's Specification	19	25	22	22	4.0+ texture

Type Of Surface	Exposure	Surface Preparation/Cleaning	Table 2- Material Reference				Minimum Total Mils Thickness
			Primer	1 ST Coat	2 nd Coat	3 rd Coat	
Wallboard (Flat)	Interior	Manufacturer's Specification	19	20	21	21	4.0+ texture
Metal Doors, Frames and Windows	Exterior and Interior	NACE-#4 1.0 Mils Surface Profile	18	20		-----	4.0
Structural and Misc. Steel	Exterior	NACE-#2 1.0-2.0 Mils Surface Profile	16	9	9	-----	5.5
Structural and Misc. Steel	Interior	NACE-#3 1.0-2.0 Mils Surface Profile	16	18	-----	-----	5.5
Piping and Valves	Interior ⁽²⁾	NACE-#3	6	17	-----		4.5
	Exterior ⁽¹⁾	NACE #2 1.0-2.0 Mils Surface Profile	6	18	9		6.0
Valves and Bolting on C.I. Pipe	Buried		-----	14	14	-----	32.0
Factory Finished Machinery, Electrical and Motors ⁽³⁾	Interior and Exterior	Hand Clean	5 ⁽⁴⁾	8 ⁽⁵⁾	8 ⁽⁵⁾	-----	4.5
Galvanized Steel	Interior	Solvent Cleaning	15	17	-----	-----	2.9
Galvanized Steel and Galvanized Pipe Conduit Threads	Exterior	Solvent Cleaning	15	18	9	-----	4.4
Wastewater Treatment Plant Equipment, Piping	Submerged ⁽⁶⁾	NACE #2 2.0-3.0 Mils Surface Profile	28	29	-----	-----	45.0
Potable Water Treatment Plant Equipment, Piping ⁽⁷⁾	Submerged	NACE #2 1.0-2.0 Mils Surface Profile	7	12	-----	-----	8.0

PAINTINGS AND PROTECTIVE COATINGS

Type Of Surface	Exposure	Surface Preparation/Cleaning	Table 2- Material Reference				Minimum Total Mils Thickness
			Primer	1 ST Coat	2 nd Coat	3 rd Coat	
Wastewater Wet-Well	Interior Surfaces	Paragraph 3.02 B	28	29	-----	-----	45.0
Special Surfaces Noted on PLANS	Surfaces as Shown on PLANS	Hydroblast and SSPC SP-7	28	29	-----	-----	125.0

NOTES:

- (1) Surface or piping above ground exposed to weathering.
- (2) Surface or piping above ground sheltered from weathering.
- (3) Use coating system per equipment Section when specified.
- (4) Optional: Use manufacturer's standard primer if compatible with specified finish coats.
- (5) Optional: Use manufacturer's standard finish coat.
- (6) Piping or equipment that is submerged or partially submerged in a fluid.
- (7) Coatings used must be in the latest publication of National Sanitation Foundation (NSF) ANSI/NSF Standard 61.
- (8) Shop priming on iron/steel materials is not required. Surface preparation and primer are done in field. Concrete surface preparation involves ¼ " wide x ¼ " deep saw cut to anchor coating to surface.

TABLE 2- COATING SCHEDULE

Symbol	Min. Dry Mils Per Coat*	Service	Generic Type	Brand and Manufacturer
1.	NA	Primary Sealer	Chemical Penetrant	Aqua-Gard-CreteGard Corp. Seal Krete-ICI Devoe #89424
2.	NA	Weather-Proof Primary Sealer	Acrylic Emulsion	ACRO 2290 DTM Acrylic Latex-ACRO Amercoat 148- Ameron Tru-Glaze 4010- ICI Devoe
3.	NA	Primary Sealer	Vinyl-Acrylic Emulsion with Epoxy Esters	ACRO 1153 Latex Block Filler-ACRO Amercoat 148- Ameron Blaxfil 4000- ICI Devoe
3A.	NA	CMU, Clear Block Sealer	Siloxane Sealer, 10% Siloxane-Acrylic Eumulsion	OKON W-2 Saver Systems WB Aqua-Trete EM- Sivento
4.	NA	Finish Coat	Acrylic Emulsion	ACRO 2288 Exterior Latex-ACRO Amercoat 220- Ameron LifeMaster-Pro 4226- ICI Devoe
5.	1.5	Metal Primer	Alkyd	ACRO 1104 Heavy Duty Primer-ACRO Amercoat 5105- Ameron Carbocoat 150- Carboline Devguard 4160- ICI Devoe
6.	2.0	Metal Primer or Concrete Surfaces	Polyamide Cured Epoxy Resin	ACRO 4422 Epoxy Primer – ACRO Amercoat 385 PA- Ameron Carboguard 888- Carboline 13-R-62-Expoxy Primer- Valspar BarRust 231- ICI Devoe
7.**	2.0-4.0 (As Recommended)	Metal Primer	Polyamide Cured Epoxy Resin	ACRO 4460 Chemical Resistant Epoxy-ACRO Amercoat 385PA- Ameron Carboguard 561- Carboline Valspar 90HS- Valspar BarRust 233H- ICI Devoe
8.	1.5	Finish Coats	Alkyd, Straight Long-Oil	ACRO 2214 Heavy Duty Enamel-ACRO Amercoat 5450- Ameron Carbcoat 139- Carboline Devguard 4308- ICI Devoe
9.	2.0	Finish Coats	Aliphatic Urethane	ACRO 4429 Polyurethane- ACRO Amercoat 450HS- Ameron Carbothane 134HG- Carboline

Symbol	Min. Dry Mils Per Coat*	Service	Generic Type	Brand and Manufacturer
				V40 Polyurethane Enamel- Valspar Devguard 389- ICI Devoe
10.	1.5	Wood Primer	Oil Base	ACRO 2214 Enamel (Thinned 10%)- ACRO Amercoat 5105- Ameron Carbocoat 139- Carboline Ulthide 2110- ICI Devoe
11.	1.5	Finish Coat	Alkyd, Straight Long-Oil	ACRO 2214 Heavy Duty Enamel- ACRO Amercoat 5405- Ameron Carbcoat 139- Carboline Devguard 4308- ICI Devoe
12.**	4.0-6.0 (As Recommended)	Submerged Steel, Iron, or Concrete Surface	Polyamide Cured Epoxy Resin	ACRO 460 Chemical Resistant Epoxy- ACRO Amercoat 370- Ameron Carboguard 561- Carboline BarRust 231- ICI Devoe
13.	10	Submerged Steel, Iron, or Concrete Surface	Coal-Tar Epoxy Two Component	ACRO 4467 Coal Tar Epoxy- ACRO Amercoat 78 HB- Ameron Bitumastic 300M- Carboline
14.	16	Buried Steel or Iron	Tar-Base Pitch	ACRO 8500 Heavy Duty Coal Tar- ACRO Bitumastic No. 50- Kop-Coat Devtar 247- ICI Devoe
15.	0.4	Galvanized Metal Primer	Vinyl Wash Primer	ACRO 1162 Vinyl Wash Primer- ACRO Galva-Prep- Ameron Rustbond Penetrating Sealer- Carboline Devran 205- ICI Devoe
16.	3.0	Steel Above Ground & Above Waterline	High Ratio Silicate Inorganic Zinc	ACRO 5502 Inorganic Zinc- ACRO Dimetcote 9- Ameron V13-F-12 Inorganic Zinc- Valspar Catha-Coat 302H- ICI Devoe
17.	2.5	Steel Interior	Polyamide Cured Epoxy Resin	ACRO 4460 Chemical Resistant Epoxy-ACRO Amercoat 385- Ameron Carboguard 561- Carboline Bar-Rust 231, Devran 224 HS- ICI Devoe

Symbol	Min. Dry Mils Per Coat*	Service	Generic Type	Brand and Manufacturer
18.	2.0	Intermediate Finish		ACRO 4460 Chemical Resistant Epoxy- ACRO Amercoat 385-Ameron Carboguard 561- Carboline Devran 220 – ICI Devoe
19.	NA	Texture	Emulsion	Ready-Mixed Texture Compound- U.S. Gypsum Speedhide Texture Emulsion- PPG
20.	1.2	Sealer	Vinyl-Latex	Quick-Drying Latex Sealer, 6-2-PPG Interior Vinyl Latex Primer-Sealer, 50801- Devoe
21.	1.4	Finish Coat-Flat	Synthetic Alkyd Resin	Alkyd flat Wall Enamel- Negley Speedhide Alkyd flat, 6 Line- PPG 50801- Devoe
22.	1.4	Finish Coat Semi-Gloss	Synthetic Alkyd Resin	Coronado Supercoat 5000 Speedhide Alkyd Lo-sheen Enamel, 6 Line- PPG Velour Interior Alkyd Semi-gloss Enamel- 26XX Devoe
23.	NA	Wood Filler	Alkyd Resin w/Linseed Oil	Paste Wood filler- Negley Natural Paste Wood filler- PPG Interior Solvent Base Paste Wood filler 4800- Devoe
24.	NA	Stain	Synthetic Alkyd Resin	Coronado Quick Seal Rez Interior Wiping Stain, Alkyd Oil Type, Quick Drying, 77-302- PPG Penchrome DF203- ICI Devoe
25.	1.0	Sealer/Primer	Synthetic Alkyd Resin	Rez sealer- Primer, 77-1- PPG
26.	1.5	Clear Finish, Stain	Polyurethane Varnish	Coronado Polyurethane 67 Series Rez Polyurethane Satin Clear Plastic Varnish, 77-89- PPG DF500-ICI Devoe
27.	1.5	Clear Finish, Gloss	Polyurethane Varnish	Coronado Polyurethane 67-10 Rez Exterior/Interior Polyurethane Gloss Clear Plastic Varnish, 77-55- PPG
28.	5	Steel, Iron or Concrete Surface	Modified Amine-Addnet Epoxy	Polybrid 670S- Polybrid Coatings, Inc. Raven 120- RLS Solutions, Inc.

Symbol	Min. Dry Mils Per Coat*	Service	Generic Type	Brand and Manufacturer
29.	40-120	Steel, Iron or Concrete Surface	Elastometric Polyurethane Aromatic	Polybrid 705- Polybrid Coatings, Inc. Raven 405- RLS Solutions, Inc.

* Or manufacturer's standard, whichever is greater. Do not exceed manufacturer's maximum standard, if applicable.

** For potable water use.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 11190
MANUAL, CHECK & PROCESS VALVES

PART 1: GENERAL

1.1 SCOPE

This section describes the valves to be provided and installed as part of this project. Valves included are butterfly, ball, check, vacuum breaker and air release valves. Injection valves are listed in Section 11213.

1.2 GENERAL

Install valves complete with operating levers, handles, or operators, as required for operation, and shown on the drawings. All valves shall have the manufacturer's name, and the size of the valve cast or molded onto the valve body, or engraved on a permanently attached tag.

PART 2: PRODUCTS

2.1 PVC (All PVC Valves 2 inches and smaller shall be a ball valve, and valves greater than 2 inches shall be butterfly valves.)

A. BUTTERFLY VALVES

1. The butterfly valves shall be wafer style, PVC butterfly valves, with gear and hand wheel operator. The valve seat and seal shall be EPDM, with disc and body of PVC. Shaft shall be 316 stainless steel. The valve shall be manufactured by Chemtrol, ASAHI America, Spears, Hayward or equal.

B. BALL VALVES

1. Plastic ball valves shall be true union type, PVC ball valves for all services. Valves shall have a service rating of 150psi at 77°F. All ball valves shall have Teflon seats and EPDM seals. Valves shall be as manufactured by ASAHI America, Chemtrol, Spears, Hayward, or equal.
2. Probing Valve – These shall be W' gray PVC ball valve with a Male NPT inlet, and W' JACO outlet, Buna-N-Seal and long handle. This valve shall allow insertion of the 14" water sample probe to pass through the valve into the pressure vessel. They are to be manufactured by The Specialty Manufacturing Company of

St. Paul, MN, phone number 651.653-0599, product number PVC 638-4M4CJB part number 7123390, or preapproved equal.

C. CHECK VALVES

1. The concentrate water check valves shall be spring loaded, insert style “silent” check valves, all of PVC construction. The spring shall be fabricated from 316 SS.
Check valves shall fit between standard 150# bolt pattern flanges, for easy removal. Spring shall installed to provide a cracking pressure of 0.5 PSIG. Valves shall be as manufactured by Check-All-Valve, or equal.

D. VACUUM BREAKER VALVES:

1. The permeate water vacuum breaker valves shall have PVC body and EPDM diaphragm. The self-sealing diaphragm shall be the only moving part. Valves shall be the VBM Series as manufactured by Plast-0-Matic Valves, or equal.

E. AIR RELEASE VALVES:

1. The permeate air release valves shall be all NSF 61 certified with reinforced nylon body, EPDM rolling seal, SS screws, and polypropylene float construction. Valves shall be the 2 inch D-040 N14 as manufactured by ARI Flow Control Accessories LTD, or equal.

2.2 STAINLESS STEEL

A. BUTTERFLY VALVES (Valves shall be designated for either low pressure 0-100 PSIG, or high pressure 100> PSIG):

1. Low Pressure – Includes the following valves including base and alternate bid RO Trains: MOV 6 H/G

Butterfly valves shall be sized as indicated in the drawings. They shall be provided with stainless steel body, stainless steel shaft and disc, EPDM seal and seats, lugged for insertion between two 150 # bolt pattern flanges and shall have a gear operator with handle or electric operator as identified on the drawings. Valves shall be made by Bray, Flowserve, Keystone, or Tyco.

2. High Pressure – Includes the following valves including base and alternate bid RO Trains: V204 H/G, V213 H/G, V214 H/G, V215 H/G, V216 H/G, V217 H/G, V218 H/G, and V 818 H/G

MANUAL, CHECK & PROCESS VALVES

11190-2

Butterfly valves shall be sized as indicated in the drawings. They shall be high performance rated valves and provided with stainless steel body, stainless steel shaft and disc, EPDM seal and seats, lugged for insertion between two 150 # bolt pattern flanges and shall have a gear operator with handle or electric operator as identified on the drawings. Valves shall be made by Bray, Flowserve, Keystone, or Tyco.

B. BALL VALVES:

1. Ball valves for pressure instrument isolation in feed water and concentrate piping, ERT, and Drain Isolation shall be 1/2 inch to 1 inch 316 SS ball valves, with operating handle. Valves shall be supplied with 316 SS "latchlock" handle, Teflon seal and seats, and shall have a two-piece threaded body. Valves shall be made by Watts Regulator, Ohio Valve Company, Sharpe, or equal.
2. Ball valves for pressure instrument isolation in the Sample Panel Isolation shall be
 - 1.1. 316 SS ball valves, 1/2 turn manual actuation with operating handle. Valves shall be supplied with both sides J Lock connection capable for SS tube connection and plastic handle, Teflon seal and seats, and shall have a two-piece threaded body. Valves shall be made by Parker-Haniffin A-Lok, Hoke, or equal.
3. Low pressure ball valve for valve MOV-6 shall be sized as indicated in the drawings. They shall be provided with stainless steel body, stainless steel shaft and ball, EPDM seal and seats, flanged with a 150 # bolt pattern, and shall have a gear operator with handle or electric operator as identified on the drawings.
Valves shall be made by Bray, Flowserve, Keystone, or Tyco.

C. CHECK VALVES:

1. The concentrate water check valves shall be spring loaded, insert style silent check valves, all of Stainless Steel construction. The spring shall be fabricated from 316 SS. Check valves shall fit between standard 150# bolt pattern flanges, for easy removal. Sealing pressure shall be 0.5 PSIG. Valves shall be as manufactured by Check-All-Valve, Titan, or equal.

D. VACUUM BREAKER VALVES:

2. The concentrate water vacuum breaker valves shall be all of Stainless Steel

construction. The spring shall be fabricated from 316 SS. Care shall be taken to insure the valve fits into the taps of the SS pipe spools to be installed on the proposed RO trains. Valves shall be as manufactured by Johnson, or equal.

2.2 CAST IRON

- A. BUTIERFLY VALVES (Valves shall be designated for either low pressure 0-100 PSIG, or high pressure 100> PSIG):

Low Pressure – Includes the following valves including base and alternate bid RO Trains: 101 H/G, 102 H/G, V6 H/G, V7 H/G, and MOV 4 H/G

1. Butterfly valves shall be sized as indicated in the drawings, and be coated to resist corrosion as identified in this specification. They shall be provided with cast iron body, stainless steel shaft and disc, EPDM seal and seats, lugged for insertion between two 150 # bolt pattern flanges and shall have a gear operator with handle or electric operator as identified on the drawings. Valves shall be made by Bray, Flowserve, Keystone, or Tyco.

- E. AIRRELEASE VALVES:

1. The raw water feed line air release valves shall have a cast iron body with Stainless Steel float and trim and a Buna-N Rubber seal. Valve shall have a 2 inch FNPT outlet. Valves shall be the AL 20 as manufactured by Crispin, or equal.

2.04 ELECTRIC ACTUATORS

Electric motor operators shall be of the bi-directional type with permanent split capacitor motor drives and mechanical brakes. The operator motors shall be 110V, single phase type, and the device shall be equipped with switches to indicate open and closed positions. The mechanism shall be enclosed in a die cast aluminum, NEMA 4 cover, with manual override in the top. Available operator torque shall be not less than 1.25 times that required by the valve manufacturer to open or close the valve. All nuts, bolts, washers, studs, etc., that are associated with the enclosure or mounting assembly, shall be 316 SS, even though this may not be the manufacturer's standard. The exposed ferrous metal parts, (gear enclosure, mounting bracket, etc.) must be coated as per section 09900 coating system to prevent rusting in service.

Operators shall be assembled with their valve by the valve manufacturer, and shall be shipped to the jobsite as a unit. Field assembly of separately supplied units will

not be permitted. Shop drawing submittals must reflect that the assembled unit is the product of the valve manufacturer.

The electric actuators shall be EIM, or equal

PART 3: EXECUTION

3.1 INSTALLATION

- A. Valves shall be carefully handled and positioned in a manner that will prevent damage to any part of the valves.
- B. All damage to surface coatings shall be painted with touch-up paint of the same color as the original paint so that the repairs are not distinguishable.

3.2 SERVICE

- A. Demonstrate to the Owner's operation and maintenance personnel the proper methods for operating and maintaining the equipment, and the contents of the operation and maintenance manual required to be submitted under Section 01300.
- B. The Contractor shall furnish to the Owner, through the Engineer, a written report prepared by the equipment manufacturer's field service technician certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts;
 - 4. Has been operated under full load and that it operates satisfactorily and in compliance with the requirements of this Section.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 11250
VERTICAL TURBINE PUMPS UNITS

1.0 GENERAL

1.1 WORK INCLUDED

- A. The Vendor shall furnish labor, materials, equipment and incidentals necessary to design, manufacture, fabricate, test, deliver and install One (1) vertical line shaft pumping unit with 460-volt motor as specified. Accessories shall be furnished as required for a complete functioning pumping unit in accordance with the specified performance and installation conditions.
- B. Pumping units shall include, but not necessarily be limited to, bowl and impeller assembly, suction basket screen, line shaft, shaft bearings, column, above the floor discharge head, motor stand, motor, motor couplings, flange bolts and gaskets, sole plate, anchor bolts, special services, spare parts, all lubrication and motor oil and all related electrical and instrumentation. Accessories shall be furnished as required for a complete functioning pumping unit in accordance with the specified performance and installation conditions.
- C. For this specification section, the Equipment Manufacturer shall be defined as the Pump Manufacturer or his designated representative. The Equipment Manufacturer shall be responsible for supplying and coordinating the design, testing, and installation of the pumps and motors. The Equipment Manufacturer shall be responsible for the adequacy and compatibility of the pump and motor. The motor manufacturer shall act as a subcontractor to the pump manufacturer, and shall provide a representative who is capable of coordinating the design, testing, and installation of the motor.
- D. The equipment manufacturer shall utilize computational fluid dynamic (CFD) modeling to evaluate the anticipated intake condition and other hydraulic conditions that can affect pump performance such as pre-swirl, relative level or turbulence, and velocity distribution. The equipment manufacturer will use CFD model to evaluate the ability to improve intake conditions through the use of improvements, such as vortex breakers.
- E. Pumping units must meet the minimum performance requirements indicated herein.

1.2 ACCEPTABLE MANUFACTURERS

- A. PUMPS:
 - 1. Flowserve
 - 2. Sulzer (Johnston)
 - 3. Peerless.
 - 4. Fairbanks Morse.
 - 5. No other manufacturers will be accepted
- B. MOTORS:
 - 1. TECO-Westinghouse.
 - 2. U.S. Motors
 - 3. Baldor.
 - 4. General Electric.

1.3 QUALITY ASSURANCE

A. EXPERIENCE REQUIREMENTS

Pumps and motors shall be the product of manufacturers who have had at least 10 years of successful experience in the design, manufacturing and application of pumping units of the type, size, and performance capabilities as specified and have a factory authorized warranty and overhaul shop in the State of Texas. The pump manufacturer shall have at least three similar size pumps of the model, type, and size of pump in service and operational for at least five 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

1.4 FACTORY INSPECTION AND TESTS

1. GENERAL

- A. Equipment furnished under these specifications shall be subject to inspection during manufacture by Engineer who shall be afforded proper facilities for determining compliance with the specifications.

2. PUMPS

- A. Pump bowl assembly shall be factory tested, and certified with factory calibrated motor and certified test copies shall be furnished to the Engineer. The efficiency, capacity, and horsepower requirements for field conditions shall be determined for not less than ten (10) points throughout the specified head range from shut-off to maximum specified operating capacity. Test procedures, interpretation and conversion of data shall conform to the latest requirements of the Test Code of the Hydraulic Institute standards, except as modified herein.
- B. Pumps shall be tested using one of the previously tested "job motors" or a calibrated shop motor at maximum rated speed and with the complete pump bowl assembly, less the suction screen.
- C. The pump test results shall indicate that the performance of the pump from run-out head to shutoff head is similar to the pump curve submitted with the bid proposal. If the test results indicate that the pump performs substantially different from that indicated in the bid proposal, the Owner, at their option, may accept the unit at a reduced price, or may refuse to accept the unit as a consequence of breach of contract. Pumps shall have a continuous down slope in the head capacity curve. Pumps with negative slopes (i.e. dips) in the Head vs. Capacity curve shall not be acceptable.
- D. Tests shall show no minus tolerance with respect to capacity, total head, or guaranteed efficiency at the specified conditions. Pumps shall have a continuous down slope in the head-capacity curve.
- E. Pumps shall be within the following plus tolerance at the rated point: 1). At rated head: +10 percent of rated capacity

2). At rated capacity: +5 percent of rated head

- F. Horsepower requirements cannot exceed nameplate motor horsepower within the specified pump operating range, including pump startup and shut down. Even if the head and capacity are within the allowable margins listed, if the nameplate motor horsepower is exceeded, the Manufacturer shall remedy the situation in a manner acceptable to the Owner at no additional cost.
- G. Perform a submergence test on each pumping unit. The test shall include operating the pump at the minimum discharge head condition with the minimum suction head available, as shown in performance requirements herein. The submergence test shall verify the pump meets NPSH margin requirements specified herein.
- H. Following completion of factory performance tests, the Vendor shall furnish to the Engineer for review and approval four (4) certified copies of all test data and test curves for each pump. Test curves shall include calculated reduced speed test curves of 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 Engineer and Owner. Copies of pump test data shall also be sent to the motor and VFD suppliers.
- I. The Manufacturer or his representative shall make metallurgical analyses from coupons cast on the piece of each pour of metal going into the castings and shafting, and shall provide certified reports to the Owner, showing that the specified alloys are being furnished, and the materials meet ASTM standards.
- J. The Manufacturer shall stress relieve all fabricated components including shaft, column pipes, and discharge head in accordance with ASME Code Section VIII, Division 1 and Section IX, and API Standard 610, prior to final machining.
- K. The Manufacturer shall perform a hydrostatic pressure test on the bowl assembly at
1.5 times the shut-off head for a minimum of 30 minutes with no leakage.

3. MOTORS:

A. 460 VOLT MOTORS

- 1). All motors shall receive an unwitnessed short commercial test in accordance with NEMA MG-1 and IEEE 112, latest version.
- 2). Following completion of factory tests, the Equipment Manufacturer shall furnish to the ENGINEER for review and approval four (4) certified copies of all test data and test curves for each motor. The ENGINEER shall promptly review test data and, upon determining that the motor meets contract requirements, authorization will be given for shipment. Shipment shall not be made without written approval of test data by the ENGINEER, except at the risk of the Equipment Manufacturer.

B. ASSEMBLY

1. It is anticipated that pump and motor may be shipped from separate points for assembly at the project site. The pumping units (pumps, column, shafts, and couplings) shall be disassembled for shipment, and the Pump Supplier shall certify that at the factory, prior to shipment, the units were completely assembled, except for the job motor, each part to each adjoining part and match-marked if appropriate. The bowl assemblies (bowls, suction bell, impellers, pump shaft, and pump bearings) can be shipped assembled only if measures are taken to block up the rotating assembly so that it is not riding in the bearings during shipment to and handling at the site. Pump line columns, line shafts, and couplings shall be disassembled and shipped as individual components. Shipping of columns with shafts installed is not allowed.
2. The Pump Manufacturer shall be responsible for coordination with the Motor Manufacturer to insure that no undue difficulty in assembly will be occasioned when units are received at the project site. If the motor or any other component does not match properly, the defect shall be corrected to the satisfaction of the Owner.

C. MARKING

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. Pump Column sections and shafts shall be marked to indicate the installation sequence.

D. SERVICE OF MANUFACTURER'S REPRESENTATIVES

1. Pump Manufacturer Representative:
 - a. The Pump manufacturer shall furnish the services of a competent factory technician, who shall have had a minimum of 5 years' experience in the installation, adjustment, and operation of the equipment which is being furnished under this contract. This service is for the purpose of insuring proper installation and adjustment of the equipment; instructing operating personnel in proper operation, maintenance, and care of the equipment; for making operation tests of equipment and making recommendations for obtaining the most efficient use thereof.
 - b. The service representative shall be at the site at any time the Construction Contractor is assembling, setting, aligning, connecting or adjusting and testing the pump and motor assembly. He shall direct and assist the Construction Contractor in the installation and certify in writing to the Owner that it has been properly installed and operates satisfactorily during acceptance tests.

- c. The minimum time required to be on-site for 8 hours, including travel time, is as follows for each pump:

Pump Barrel Installation	2 days (1 trip minimum)
Pump and Motor Installation	5 days (1 trip minimum)
Pump Start-Up and Testing	7 days (2 trips minimum)

Troubleshooting	5 days (2 trips minimum)
Personnel Training	1 day (1 trip minimum)

2. Motor Manufacturer Representative

- a. The motor manufacturer shall furnish the services of a competent factory technician, who shall have had a minimum of 5 years' experience in the installation, adjustment, and operation of the equipment which is being furnished under this contract. This service is to ensure proper installation and adjustment of the motor, instruct personnel in proper operation, maintenance, and care of the equipment, for making operation tests of equipment, and recommendations for obtaining the most efficient use thereof.
- b. The service representative shall arrive at the site after the motor installation but prior to testing and start-up. He shall verify the proper installation, alignment, wiring, lubrication, and connection of all appurtenances prior to start-up. He shall be present during testing and start-up and shall certify to the Owner in writing that the motors have been properly installed and operate satisfactorily.
- c. The minimum time required to be on-site for 8 hours, including travel time, is as follows:

Check Motor Installation	2 days (2 trip minimum)
Pump Start-Up and Testing	2 days (2 trips minimum)
Troubleshooting	2 days (2 trips minimum)
Personnel Training	1 day (1 trip minimum)

E. Lateral and Critical Speed Analysis:

1. The pump speed of the pumps will be varied by VFD's and will operate for extended periods of time at speeds from 60 to 100 percent of the rated synchronous motor speed. Pumps may operate at different speeds simultaneously.
2. The Equipment Manufacturer shall perform a lateral dynamic analysis and a torsional dynamic analysis of the complete pump and motor assembly to verify that there shall be no resonant vibration of the unit at any operating speed from full synchronous motor speed to 60 percent of synchronous speed. A review shall be made with respect to the pump shaft diameter and column thickness in order to insure sufficient

pump rigidity in terms of good engineering practice.

3. A Structure Dynamic Analysis (Reed Frequency Analysis) of the pump and motor assembly shall be conducted on the pump and motor to verify its structural integrity. The Equipment Manufacturer shall advise the OWNER of the calculated resonant frequency of the pumping unit and shall verify its accuracy when the unit is installed at the project site. If a resonant frequency problem exists for the installed unit, the Equipment Manufacturer shall be responsible for correcting the problem.
4. The pump manufacturer shall perform a Forces and Moment analysis of the pump discharge head for the piping arrangement shown on the plans to be assured that the discharge is designed to properly withstand the forces and moments associated with a full speed closed valve startup, shutdown, and normal operation for this application. The discharge head shall be designed to accommodate maximum thrust conditions, with a non-restrained discharge pipe and header. Certified calculations shall be submitted to the OWNER.

1.5 SUBMITTALS

A. BID SUBMITTAL

1. Submit the following information in order to evaluate the bids.
 - a. General: Furnish a complete description of all equipment offered under these specifications, including catalogs, cuts and pertinent engineering data. When the bidder's product differs from the specified requirements and/or catalog description, each point of difference shall be clearly stated. This requirement is set forth to facilitate the review of bids and not to be construed by the Bidder as waiving any of the requirements of the specifications.
 - b. Characteristic Pump Curves: Characteristic pump curves for the pump offered shall be submitted with the bid. Curves shall show the capacity, head, efficiency, required NPSH, and brake horsepower throughout the operating range of the pump from shut-off to maximum specified operating capacity. Submit curves with the above data at speeds of 60 percent to 100 percent. Characteristic curves shall have the capacity plotted as abscissa and the operating head, brake horsepower, efficiency and required NPSH plotted as ordinates.
 - c. Data Sheet: Submit information requested on the Data Sheet.
 - d. Outline Drawings: Submit outline drawings of the pump, motor and appurtenances, showing layout dimensions of the proposed equipment.
 - e. Provide maximum backspin speed during power failure, and confirmation from the pump and motor manufacturers that the equipment is suitable for the maximum backspin speed.
 - f. Pump and Motor Testing Information: Provide information on the pump and motor testing facility, location and test method. Provide a testing schedule and plan.
 - g. Provide a description of the components that will be shipped separately, thus requiring field assembly. Provide a general description of the

- installation requirements, including sequence and installation tolerances.
- h. Provide a plan and a schedule indicating dates for submittals, manufacturing, testing, and delivery.
 - i. Provide references for Owners who have the same model and size pump in use.
 - j. Provide a copy of pump Manufacturer's quality system registration to ISO9001.
 - k. Provide resume' of proposed Pump Supplier's Representative for field services.
 - l. Provide resume' of proposed Pump Supplier's Project Manager.
- B. Submittals shall be in accordance with this Section, the General Requirements, Section 01 33 00 "Submittal Procedures" and ANY DEVIATIONS FROM THE SPECIFICATIONS SHOULD BE CLEARLY NOTED AND IDENTIFIED IN THE SHOP DRAWING SUBMITTALS:
- 1. Shop Drawings:
 - a. Drawings shall show complete physical description and performance capabilities of the equipment, including, but not necessarily limited to dimensions, weights, materials, assemblies, sectional views, performance curves, four quadrant curves and WR^2 power requirements and ratings, power requirements and ratings, rated voltage and amperage, wiring diagrams as may be applicable, and on-site storage requirements. Provide detail drawings of pump barrels.
 - b. Submit drawings as a complete package of all equipment furnished. Partial drawings will not be reviewed. Shop drawings shall include the following:
 - 1). Pump Outline drawings showing all components, anchor bolts, external connections, and appurtenances
 - 2). Pump Sectional drawings with all components identified
 - 3). Characteristic curves showing capacity, head, efficiency, NPSHr, and brake horsepower at each operating speed from 60 percent to 100 percent speed
 - 4). Name plate data sheets
 - 5). Oil type and maintenance procedures
 - 6). Paint selection chart
 - 7). Lateral and Critical Speed Analysis, including raw data input into the analysis
 - 8). Certified calculations of the Forces and Moment Analysis of the pump discharge
 - 9). Pipe layout drawings for drainage and pre-lube piping.
 - 10). Shipping weights and dimensions, and center of gravity for lifting
 - 11). Bearings information, cut sheets, plan and section and data sheets and bearings life calculations
 - 12). Submit drawings of lab testing set-ups, test procedures, testing equipment calibration certification, and sample performance calculations
 - 13). Identify sequence and tags for terminal strips and wiring

- 14). Terminal strip arrangement, wiring diagrams, bill of materials, cut-sheets, etc. for vibration monitoring systems.
 - c. Include life-cycle costs, estimated annual power consumption, type of maintenance required and projected frequency of maintenance. Provide motor information to be submitted per sections 2.02. I and 2.03H.
 - d. Provide a list of at least three similar units in service supplied in the last 5 years and a name and telephone number for a reference for each of these installations.
2. Provide results of lateral and critical and confirmation from the motor supplier, forces and moment analysis of the pump discharge head, and torsional analysis of the motor, shaft coupling, and driven equipment combination.
3. Submit motor name plate data and complete wiring diagrams.
4. Submit lab set-up sketches, test procedures, testing equipment, test equipment calibration certification, and sample calculations.
5. Operation and Maintenance Data: Manuals shall be prepared by the equipment Manufacturer per Section 01 78 23 "Operations and Maintenance Data" and shall incorporate storage and installation instructions and operation and maintenance procedures, appropriate final certified shop drawings, all certified test reports, performance curves, and test data. Manual shall include nameplate data including serial numbers. Provide O&M data for all pump, motor, and accessories. Provide set points for vibration sensors, motor thermal switches, and all other protection devices. 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. Separate or combined manuals may be provided for pump and motor. Manuals shall be in hard copy and electronic format.
6. Certified Test Reports (CTR)
 - a. Provide CTR for pump factory performance tests.
 - b. Provide CTR for motor factory performance tests.
 - c. Provide CTR for pump concentricity and parallelism machining measurements
 - d. Provide CTR for metallurgical analysis of castings and shafting.
 - e. Provide CTR for bowl hydrostatic tests.
 - f. Provide CTR for pump field tests.
 - g. Provide written certification that column pipe and discharge head were stress relieved with heat prior to machining.
7. Submit Equipment Installation Reports from the motor manufacturer and pump manufacturer indicating the equipment was installed in accordance with the manufacturers' instructions and that the equipment was adjusted and aligned to be in the best operating condition. The report shall also indicate that the equipment is operating satisfactorily in accordance with the project specifications.
8. The pumps and motors shall be designed so that no damage will occur from turning forward or reverse at speeds of 140% of rated speed or at speeds which will be generated by the operating head in the pipe discharge system, whichever is greater. Show calculations that line shafting is adequately sized for the reverse

torque this condition will produce.

1.6 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Water Works Association (AWWA) Standards:

AWWA C210	Liquid Epoxy Coating Systems
AWWA E101	Vertical Turbine Pumps - Line Shaft Type
AWWA E103	Horizontal and Vertical Line-Shaft Pumps

2. American National Standards Institute (ANSI)
3. American Society of Mechanical Engineers (ASME)
4. American Petroleum Institute (API)
5. American Standards for Testing and Materials (ASTM)
6. National Electrical Manufacturers Association (NEMA)
7. NSF International Strategic Registrations, Inc. (NSF)
 - a. NSF Standard 61 – Drinking Water System Components
8. Test Code of the Hydraulic Institute Standards (HIS)
9. Institute of Electrical and Electronic Engineers (IEEE)
10. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
11. Underwriters Laboratories (UL)
12. National Electrical Code (NEC)

1.7 DELIVERY AND STORAGE

- A. The Vendor shall be responsible for delivery of the pumps, motors, and accessories, f.o.b. to the job site in good condition and undamaged. Equipment may be delivered prior to time of installation to a storage site as may be designated by the Installation Contractor and approved by the Owner in good condition and undamaged. The Vendor shall submit a shipping notice and storage and installation instructions at least one week prior to shipment.
- B. Oil for motor shall be provided by the Motor Manufacturer.
- C. Unloading and storage (hoisting equipment and rigging) of the pumping units and components shall be the responsibility of the Installation Contractor who shall inspect the components for apparent damage. Pump units and/or components that are found to be damaged will not be accepted until properly repaired or replaced by the Vendor.
- D. Pumps shall be stored in a weather protected environment. Motors shall be stored indoors and shall have space heaters energized at all times. The pump and motors will be stored by the Installation Contractor until installation, testing, and startup.
- E. Pumps and motors shall be shipped and stored per these specifications and the manufacturer's recommendation.
- F. Shipping and storage crating provided by the Pump Supplier shall allow the impeller

assembly shaft to be rotated periodically. The manufacturer shall make recommendations for rotation frequency and procedure.

- G. Vertical pump columns and shafting shall be disassembled for shipping. Shafts shall be crated with adequate blocking to prevent distortion and binding. Pump bowls may be assembled for shipping; however, provide adequate blocking to protect shaft and bearings.
- H. Spare parts shall be shipped and suitable for long term storage at a location designated by the Owner.
- I. Furnish anchor bolts as necessary to meet the Installation Contractor's schedule.

1.8 EQUIPMENT WARRANTY

- A. The equipment shall be guaranteed to meet or exceed the design criteria detailed in these contract documents. The equipment supplier shall warrant the equipment for a period of two (2) years from date of final acceptance of the entire project.
- B. In the event of failure in material or workmanship or equipment design of any part or parts of the equipment during the warranty period, provided that the equipment has been operated and maintained in accordance with good practice, the Vendor shall furnish, deliver, and install the defective part or parts at Vendor's own expense. Parts and shipping costs shall be borne by the Vendor.

1.9 PERFORMANCE REQUIREMENTS AND SETTING

A. General:

1. **SRWA Transfer Pump Station:** One (1) vertical line shaft unit (TP3). The pump will discharge above the operating floor with the motor stand, sole plate and fabricated discharge head by T316. The pumps shall have product lubricated bearings.
2. Liquid to be pumped is treated potable water with chlorine/chloramines with no abnormal amount of silt or abrasives. The pumps will be used to for pumping potable water at the Transfer Pump Station to the Ground Storage Tank.
3. All wetted materials shall be designed for drinking water contact and shall meet the intent of NSF standard 61. Leaded bronze materials shall not be used.
4. Pumps will be started and stopped against a partially closed modulating butterfly valve which will open and close very slowly to meet the specified low flow and high flow conditions for backwashing the filters. During power failure, the check valve will quickly close to prevent reverse flow through the pump. The pumps and motors shall be designed so that no damage will occur from turning forward or reverse at speeds of 140% of rated speed or at speeds which will be generated by the operating head in the pipe discharge system, whichever is greater. Show calculations that line shafting is adequately sized for the reverse torque this condition will produce.
5. Pump columns will drain down below the pump after the pump is stopped, thus the upper bearing may not be submerged prior to a pump start. Provide pre-lubrication of the column shaft and bushings during motor start sequence. The pumping units will be started with variable speed motors. The pump discharge piping will have an outlet for an air valve assembly that will release air at pump start-up and allow air

into the pump column when the pump stops.

6. The system curves included in the specification show the system heads at the design conditions at which the pumps will operate, and the pumps will operate alone or in parallel with other pumps at the range of speeds specified.

7. The pumping heads tabulated below are total dynamic heads (TDH) under field conditions and are exclusive of all pump losses from suction bell to pump discharge. It is desired that the pump have its highest efficiency near the rated points, and this efficiency, as well as the pump's efficiency at its minimum and maximum operating heads, will be used in evaluating the pumps.

8. Pumps shall have a continuously rising performance curve from pump run-out to shutoff head, with no intermediate flat places.

9. The pumps shall have suitable Net Positive Suction Head Required (NPSHR). The NPSH margin, (i.e., ratio of NPSHA to NPSHR) shall be consistent with the suction energy conditions as defined by the HIS. Minimum margin shall be 10 percent at BEP, or five (5) feet, whichever is greater. The NPSHR with the margin applied at BEP shall be less than the NPSHA with the minimum suction water level as shown in the pump setting tables.

B. SRWA Transfer Pump Station:

1. Pump Selection: Listed below are the performance requirements for the SRWA Pump Station. The pump will operate on a Variable Frequency Drive from 60% to 100% speed.

2. Pumping Conditions: The tabulations below show the required flows and various head conditions at which the pump must operate and the pump setting requirements for the high service pump.

Pumping Conditions	Transfer Pump
Rated Condition Capacity, gpm	8340
Rated Head, ft.	55
Speed, RPM	1191
Motor	Vertical Hollow
HP	150
F/L Speed	1185
F/L Amps	169
Phase/HZ/Volts	460v

3. Pump Settings:

Pump Setting	Transfer Pump
Elev. Operating Floor	24.0
Pump Discharge Diameter	24
From Shaft Centerline to Plain End Discharge	***
Elev. of Discharge Centerline	***
Elev. Maximum Water Level	9.0
Elev. Minimum Water Level	6.0
Elev. Bottom of Wet Well	4.0
Floor Opening	**

****The existing pump floor opening is approximately 38-inches. Field Verify**

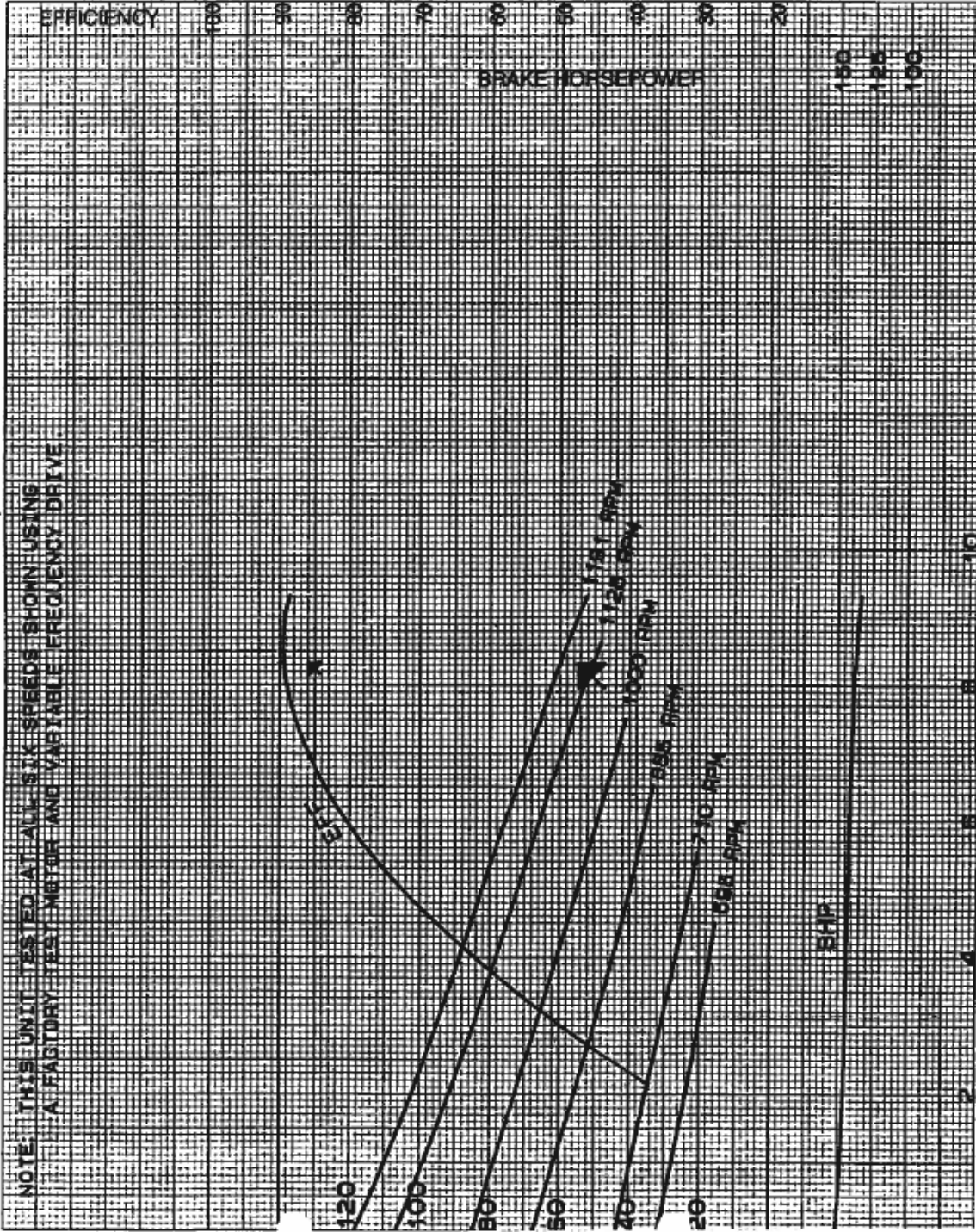
*****Pump manufacturer shall coordinate dimensions with Contractor prior to fabrication of the pump.**

Note to Contractor: Contractor is responsible for any modifications required to mount pumps in position.

SERIAL NO. 517037-0 NO. STAGES ONE SIZE-MODEL 23HLC-7000W
 TEST DATE 06/17/03 DRIVER TM-150 MTR IMPELLER T71MC998
 CERTIFIED CORRECT BY John L. Morris DATE 06/03 IMPELLER DIA. 13.1"
 TEST DEPARTMENT RPM(S) 1191

PROJECT 085535 CERTIFIED PUMP PERFORMANCE CURVE

NOTE: THIS UNIT TESTED AT ALL SIX SPEEDS SHOWN USING A FACTORY TEST MOTOR AND VARIABLE FREQUENCY DRIVE



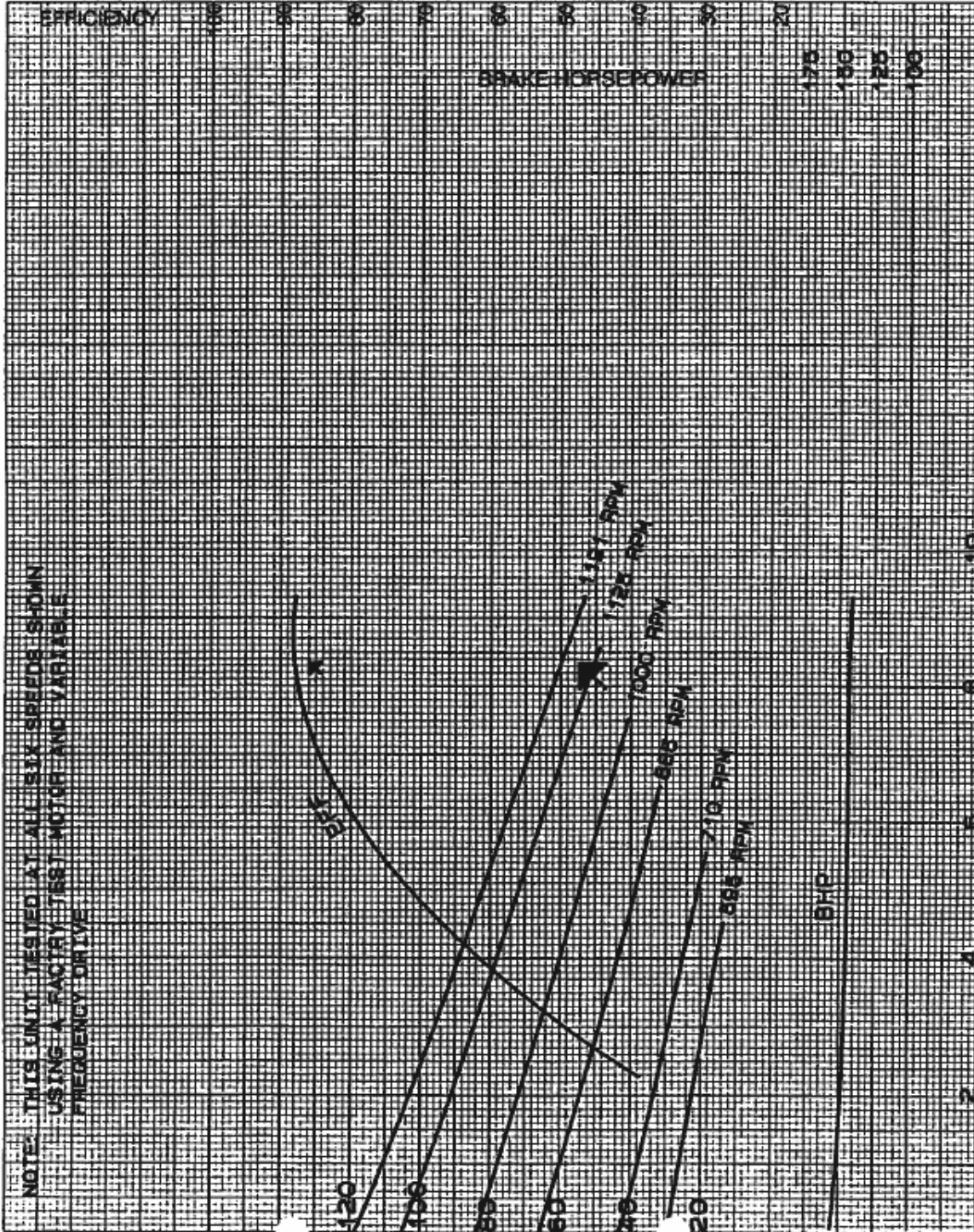
U.S. GALLONS PER MINUTE X 1000

SERIAL NO. 517037-1 NO. STAGES ONE SIZE-MODEL 23HLC-7000W
 TEST DATE 06/17/03 DRIVER TM-150 MTR IMPELLER T7LMC99B
 CERTIFIED CORRECT BY J. C. [Signature] DATE 06/03 IMPELLER DIA. 13.1"
 TEST DEPARTMENT RPM(S) 1191

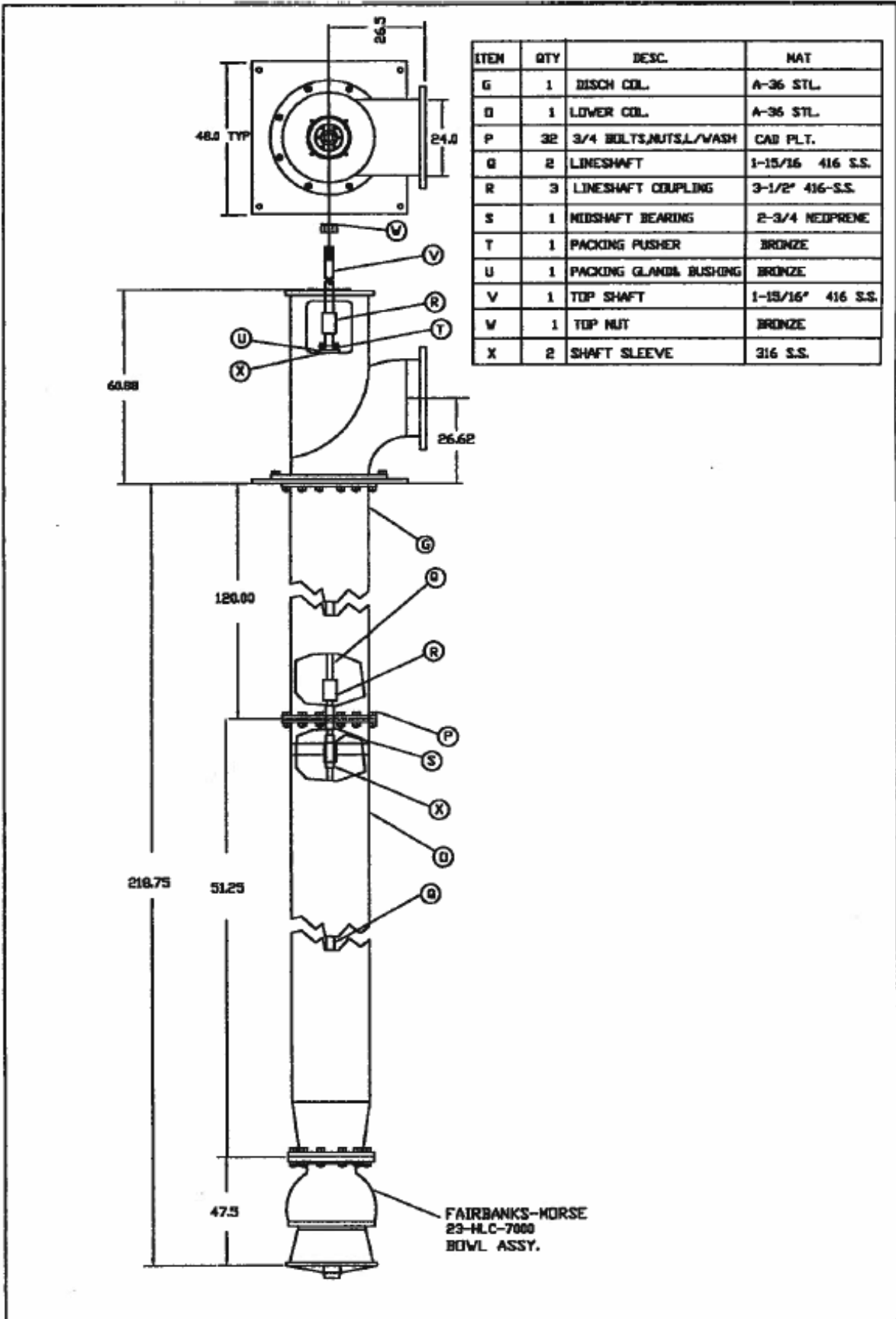
CERTIFIED PUMP PERFORMANCE CURVE

PROJECT NO. 0855535

NOTE: THIS UNIT TESTED AT ALL SIX SPEEDS SHOWN
 USING A FACTORY TEST MOTOR AND VARIABLE
 FREQUENCY DRIVE



US GALLONS PER MINUTE X 1000



VERTICAL TURBINE PUMPS UNITS

11250-15

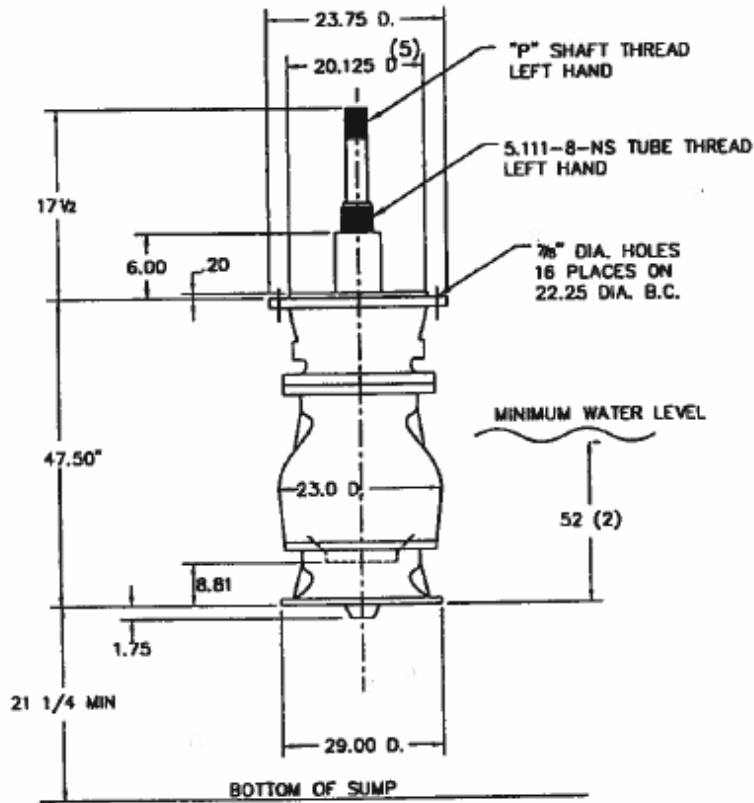
FAIRBANKS MORSE PUMP CORPORATION
MATERIAL LIST
MODEL 7000 OPEN LINESHAFT , FABRICATED HEAD, VHS DRIVER


ITEM	DESCRIPTION	MATERIAL	SPECIFICATION
1	TOP SHAFT ADJ NUT	STEEL	A108 GR 12L14
6	WATER SLINGER	RUBBER	NEOPRENE
7	DISCHARGE HEAD	STEEL	A53 GR B & A283 GR D (4)
8	GLAND BOLT	STAINLESS STEEL	AISI 304
9	PACKING GLAND	CAST IRON	A48 CL30
11	GASKET	TAG BOARD	F104
13	TOP SHAFT SLEEVE	STAINLESS STEEL	AISI 304
15	PACKING	SYNTHETIC	COMMERCIAL
16	COLUMN FLG GASKET	TAG BOARD	F104
17	PACKING BOX	CAST IRON	A48 CL 30
17A	PACKING BOX BUSHING	BRONZE	B505 AL 932
19	TOP SHAFT	STEEL	AISI 1045
21	TOP COLUMN	STEEL	A53 & A283 GR D (4)
23	LINESHAFT	STEEL	AISI 1045
25	BEARING RETAINER (6)	BRONZE	B583 AL836
26	BEARING	RUBBER	COMMERCIAL
27	SNAP RING	STAINLESS STEEL	COMMERCIAL
27A	THRUST RING	STAINLESS STEEL	A582 S41600
29	LINESHAFT SLEEVE	STAINLESS STEEL	AISI 304
30	BOTTOM COLUMN	STEEL	A53 & A283 GR D (4)
31	SHAFT COUPLING	STEEL	A108 GR 12L14
32	PUMP SHAFT	STAINLESS STEEL	A582-416
34	TOP BOWL BEARING	BRONZE	B505 ALLOY 932
35	INTER BOWL BEARING	BRONZE	B505 ALLOY 932
36	INTER BOWL	CAST IRON (2)	A48 CLASS 30
36W	BOWL WEAR RING	BRONZE	B505 AL 932
38	IMPELLER	BRONZE	B584 AL836/875 (3)
38A	IMPELLER KEY	STEEL	A108 GR 1018
38W	IMPELLER WEAR RING	BRONZE	B505 AL 932
40	SUCTION BELL	CAST IRON	A48 CLASS 30
41	SUCTION BEARING	BRONZE	B505 ALLOY 932
50	CONNECTOR BEARING	BRONZE	B505 ALLOY 932
54	DISCHARGE CASE	CAST IRON	A48 CLASS 30
55	TOP INTER BOWL	CAST IRON	A48 CL 30
58	SAND COLLAR	STEEL	A519 GR 1018
59	SUCTION BOWL PLUG	CAST IRON	COMMERCIAL
63A	GASKET	COPPER	B152 ALLOY 110
88	SET SCREW	STEEL	SAE BOLT STEEL

1. Material specifications shown are ASTM unless otherwise specified and are for description of chemistry only.
2. Bowls are epoxy coated
3. Manufacturer's option
4. Circular sections are A53 and plate is A283 Gr D
5. A step connector bearing may be used when lineshaft is different size than pump shaft.
6. Bearing Retainers for column larger than 16" are fabricated integral with the column.

ML-7000

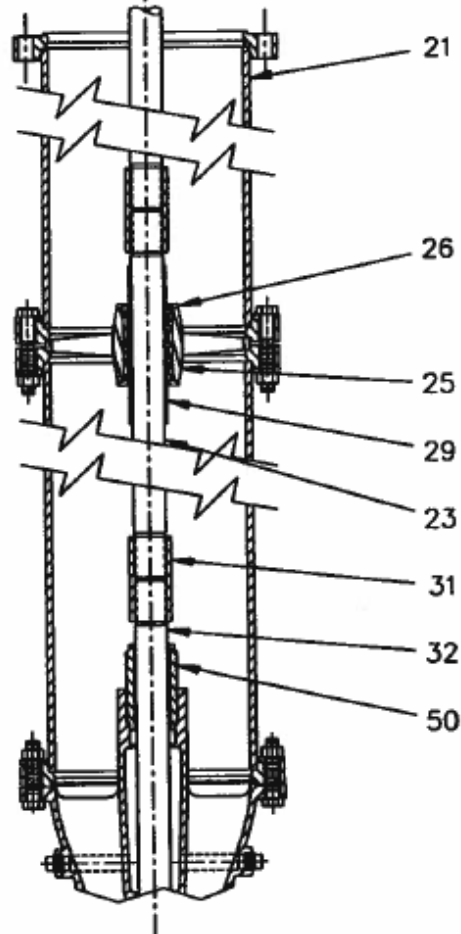
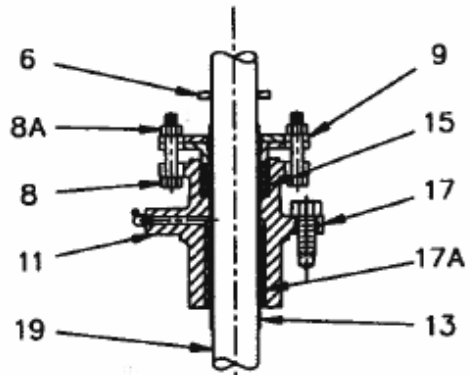
- NOTES: 1. DIMENSIONS SHOWN ARE IN INCHES UNLESS OTHERWISE NOTED.
 2. MINIMUM SUBMERGENCE AT MAXIMUM FLOW
 3. NOT FOR CONSTRUCTION, INSTALLATION OR APPLICATION UNLESS CERTIFIED.
 4. DIMENSIONS SHOWN MAY VARY DUE TO NORMAL TOLERANCES.
 5. TOLERANCE IS $+.005/-0.000$ "
 6. "P" SHAFT THREAD
 $1\frac{1}{2}$ " 10P
 $1\frac{1}{16}$ " 10P
 $1\frac{3}{16}$ " 10P
 $2\frac{3}{16}$ " 10P



CUSTOMER A & H ENTERPRISES		P.O. A-2924			
JOB NAME SOUTHMOST REGIONAL WATER AUTHORITY					
PUMP SIZE & MODEL 23HLC 7000AW	STAGES 1	GPM 8340	TDH 55 FT.	RPM 1191	ROT CCW
MOTOR BY OTHERS	HP 150	FRAME	PHASE	HERTZ	VOLTS ENCL
CERTIFIED FOR FM PROJECT NO. 085535		CERTIFIED BY JBH		DATE SEPT. 2002	
DWG. NO. SP-085535				REV	

SETTING PLAN
 23HLC 7000
 SINGLE STAGE
 BOWL ASSEMBLY

175# PACKING BOX



FLANGED COLUMN

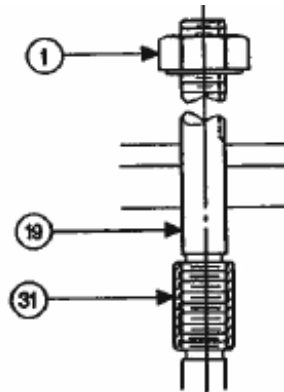
OPEN LINESHAFT
COLUMN SECTIONS

Fairbanks Morse
Pump Corporation

DWG NO 7000A041 REV NO 0

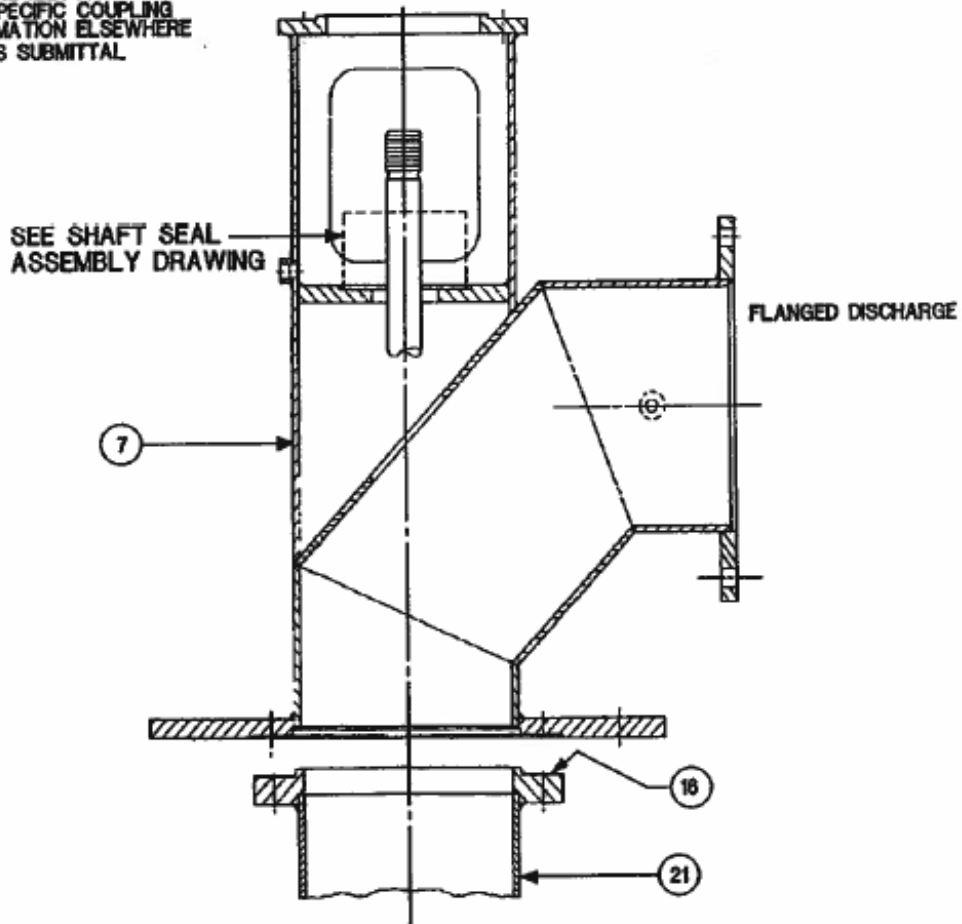
VERTICAL TURBINE PUMPS UNITS


11250-18



VERTICAL HOLLOW SHAFT DRIVER

NOTE:
TYPICAL ILLUSTRATION
SEE SPECIFIC COUPLING
INFORMATION ELSEWHERE
IN THIS SUBMITTAL




ASSEMBLY DRAWING FOR TYPE 'F' DISCHARGE HEAD
<small>1977 T.W.C.</small>

**Fairbanks Morse Pump
Technical Data**

Bowl Assembly	
Size.....	23HL
Pump Shaft Diameter.....	2-7/16
Bowl Ring Clearance.....	0.087/0.031
Impeller	
Impeller Eye Area (Sq-In).....	134.8
Maximum Sphere Size.....	1.88
Thrust Factor, K_1 (Lbs./Ft.).....	69
Rotor Weight per Stage, K_2 Lbs.....	155
Bowl Weight. (First Stage) Lbs.....	961
Bowl Weight. (Each Additional Stage) Lbs.....	695
Allowable Shaft Stretch.....	.88
WK^2 (First Stage) (Lbs-Ft ²).....	36.4
Submergence, above suction bell (minimum at maximum flow).....	51

Note 1. Values shown are in inches unless otherwise noted

FAIRBANKS MORSE PUMP CORPORATION

SERIES 20 POTA-POX

Description & Typical Use:

A Epoxy-Polyamide Potable Water Tank System. Used as a coating system for steel tank interiors, exteriors and concrete reservoirs for potable water storage. Acceptable to the U.S. Environmental Protection Agency for contact with potable water

Surface Preparation:

Immersion Service SSPC-SP10

Technical Specifications

Number of coats:	2
Colors:	(Customer to specify)
20-1211	Red
20-1255 (Primer)	Beige
20-2000 (Finish)	White
Dry Film Thickness:	
20-1211 & 20-1255	3.0 to 5.0 mils per coat
20-2000	4.0 to 6.0 mils per coat

SURFACES TO BE COATED

Interior and exterior of bowl assembly, interior and exterior of column and interior of discharge head (including wetted portions of packing box) and un-machined areas of bottom of discharge head.

FAIRBANKS MORSE PUMP CORPORATION

TNEMEC 66 HI-BUILD EPOXOLINE

Description & Use:

Chemical and corrosion resistant coating system for protection against abrasion, moisture, corrosive fumes, chemical contact and immersion.

TYPICAL USE: Coating structural steel, tank interiors and exteriors, pipes, machinery and equipment, concrete floors, shower and locker rooms, corridors, food preparation areas, operating rooms and laboratories.

Meets the requirements of the United States Department of Agriculture for application to structural surfaces or surfaces where there is a possibility of incidental food contact in official establishments operating under the Federal Meat and Poultry Products Inspection Program

Surface Preparation:

Prepare surfaces by method suitable for exposure and service.

Non-immersion Service: Commercial Blast Cleaning (SSPC-SP10)

Technical Specifications

Number of coats:	2
Colors:	**<u>Gray-ANSI BK 66</u>
Theoretical Coverage:	896 mil sq. ft. per gallon
Dry Film Thickness:	4.0 TO 6.0 mils per coat

Clarification

** Unless otherwise specified the equipment supplied on this order will be painted the color shown above.

Surfaces To Be Coated

Exterior of discharge head.

2.0 PRODUCTS

2.1 PUMPS

A. General:

1. Pump shall be open line shaft product lubricated type, single or multi-stage vertical turbine or mixed flow type pump with enclosed or semi-open impellers.
2. Pumps shall be designed, manufactured, inspected and tested in accordance with the applicable requirements of AWWA E103, the Hydraulic Institute Standards and special requirements of this specification.
3. The down-thrust load imposed on the impellers and line shaft will be carried by the upper thrust bearing of the motor, which shall be designed for the maximum load imposed. The impellers may be thrust balanced at the option of the manufacturer to assure the adequacy of the motor bearings to carry the load.
4. If an up-thrust load occurs at any specified pumping condition, including pump start-up, the pumping unit shall be designed to withstand the worst case load without any damage to the unit. The Vendor shall make such measurements during the acceptance tests to determine that no damaging up-thrust condition exists, and shall be responsible for correcting such problems that may occur.
5. The pumps shall have water lubricated shaft bearings and an open line shaft.
6. The Pump Manufacturer shall stress relieve all fabricated components, column pipe, motor stand, and discharge head prior to final machining in accordance with ASME Code, Section VIII, Division 1, ASME Code Section IX, and API Standard 610. Furnish stress relief certificate from vendor supplying furnace.
7. Pumps shall be designed, manufactured, and installed to meet all requirements of the ANSI/HI 9.6.4-2009 standards for "Allowable Field Vibration Limits" except as modified below:
 - a. Pumps shall have less than 0.085 in/sec RMS unfiltered in the x, y, and z direction when measured at the bottom motor flange.
 - b. Pumps shall have less than 0.15 in/sec RMS unfiltered in the x, y, and z direction when measured at the top of the motor upper bearing housing.
 - c. These limits shall apply anywhere within the preferred operating region of the pump and at the full rotational speed. The limits shall not be exceeded by more than 30% outside of the preferred operating range but within the allowable operating range.

B. Bowl Assembly:

1. Bowls: The suction bell and pump bowls shall be of cast ductile iron ASTM A536; or cast steel ASTM A27, Class 65-35 or ASTM 216 grade WCB, free of blow holes, sand holes, or other detrimental defects, with smooth water passages. The top case, impeller case, and suction bell shall be located by a register fit for ease of re-assembly and to maintain alignment during operation. All bowl flange fasteners shall be stainless steel.
2. Bearings: The lower bowl shall have a suitable suction bell and a sealed permanently grease lubricated lower bearing. Bowl assembly shall have a shaft bearing above and below each impeller. Bearings shall be bronze, ASTM B271, alloy C93200.
3. Wear Rings and Bowl Liners:
 - a. Bowls for enclosed impellers shall be fitted with renewable wear rings at the running joint(s) with the impeller. Bowls for semi-open or axial flow impellers shall be fitted with renewable bowl liners and wear rings at the running joint(s) with the impeller. Rings and bowl liners shall be securely attached or dowelled to prevent rotation in their seats. Rings shall be forgings. No spin cast rings will be allowed. Wear rings shall have straight face only, no L-shaped rings will be allowed. Rings and liners shall be 400 Series stainless steel and compatible with the stainless steel impeller material and shall be an alloy with a Brinell hardness of 100 points greater than the impeller wear rings.

C. Rotating Assembly:

1. Impeller Shaft:
 - a. The impeller shaft shall be stainless steel, ASTM A-479, Type 410 Condition 1; ASTM A582, Type 416; or ASTM A-564, Type 17-4PH. Keyways in the shaft shall be provided with Type 410 stainless steel keys which shall properly space the impellers on the shaft and transfer thrust and torsion loads from impeller to shaft. Assemble using anti-seize compound on fasteners as necessary to prevent galling.
2. Impellers:
 - a. Impellers for each pump application shall be as stated in section 2.01A.1.
 - b. Impellers shall be of strong dense castings free of structural defects with uniform thickness of vanes and shrouds. They shall have smooth water passages for high efficiency and shall be statically and dynamically balanced to ISO 1940, Balance Grade G2.5.
 - c. Impellers shall be of cast stainless steel, ASTM A487, CA-6NM Class "B" containing 13 percent chrome and 4 percent nickel or shall be of cast nickel aluminum bronze, ASTM B148, C95800.
 - d. No fillers and or coatings of any type will be allowed on the impellers. Welding on the raw castings will be allowed as long as the proposed repaired defect is within allowable standards and prior to any machining, polishing, and or balancing. Welding, fillers, or coatings for head, flow, and/or efficiency performance reasons will not be allowed.

3. Wear Rings:
 - a. Enclosed impellers shall be fitted with renewable wear rings at the running joint(s) with the bowl. Rings shall be securely attached or dowelled to prevent rotation in their seats.
 - b. Semi-open or axial flow impellers shall be machined to the exact contour of the bowl liner surface.
 - c. Wear ring and bowl liner material shall be 400 Series stainless steel and be compatible with the stainless steel impeller material, and shall be an alloy with 100 points Brinell softer than the bowl wear rings.
 - d. Wear rings shall have straight face only, no L-shaped rings will be allowed. No spin cast rings will be allowed. Wear rings shall be forgings.
- D. Open Line Shaft and Bearings:
 1. Shaft: Line shaft and couplings shall be stainless steel, ASTM A-479, Type 410 Condition 1, or ASTM A-564, Type 17-4PH, of size conforming to AWWA E103 and shall be furnished in interchangeable sections with lengths not greater than 10 feet or as required to be assembled or disassembled at the job site. Shafts shall have butting faces, machined square to the axis of the shaft to ensure accurate alignment. The top line shaft section shall have a stainless steel shaft sleeve where it passes through the shaft seal and bushing. The shaft sleeve shall be 410 stainless steel and shall be 50 points Brinell greater hardness than the shaft, minimum. Assemble using anti-seize compound on fasteners to prevent galling. Shafting shall be straight to within 0.003 inches TIR at any point along the length of the shaft. Any shaft not meeting this requirement shall be replaced. Repairing or straightening shafts shall not be allowed.
 2. Couplings: Couplings shall be designed with a safety factor of 1-1/2 times the shaft design strength. Use anti-seize compound for all threaded fasteners. Couplings may be threaded for shafts less than 2-1/2" in diameter. Couplings for shafts 2-1/2" and larger shall be keyed lock type couplings to prevent loosening from reverse torque of the shaft. All parts shall be stainless steel and threaded parts shall be assembled using an anti-seize compound.
 3. Bearings:
 - a. Open Line Shaft
 - 1). Line shaft bearings shall be cutlass rubber, Neoprene 65 shore, and shall be bronze backed marine style with low swell rubber compound. The use of pop-in, glue-in bearings shall not be acceptable.
 - 2). Bearings shall be lubricated with the liquid being pumped. Bearings shall be mounted securely in stainless steel 316L lined bearing retainers which are welded integrally to the pump column at each column flange. The bore of the integrally welded bearing retainer shall be machined concentric to the column flange registers and perpendicular to the flange faces.
 - 3). Each bottom and intermediate column pipe shall contain a bearing assembly.

E. Pump Column:

1. The column pipe shall be such that the friction loss does not exceed 5' per 100' of column at the rated capacity of the pump. Column pipe 24-inches in diameter and larger shall have a minimum wall thickness of 0.5-inches. Column pipe less than 24- inches in diameter shall have a minimum wall thickness of 0.375-inches. The pipe shall be furnished interchangeable sections of not more than 10' lengths. Column pipe shall be connected with flanged type connection using stainless steel bolts and nuts with hardened washers on both ends, and anti-seize compound. Column pipe shall be stress relieved with heat prior to machining of flanges and shaft retainers. The ends of each flanged section shall be faced parallel and machined accurately with register fit, to insure proper alignment when assembled. Concentricity of shaft bearing to column flange register fit shall be 0.005" TIR or manufacturer's recommended tolerance, whichever is less. Parallelism of column pipe shall be 0.005" TIR or manufacturer's recommended tolerance, whichever is less. All flange registers shall be identical so that any section of column and shaft can be installed in any location in the column. Column flanges shall have an "O"-ring suitable for pump shut-off pressure. "O"-ring groove shall be on the bottom flange. Column pipe material shall conform to ASTM A53 or ASTM A120. For column pipe 24-inch in diameter or larger, include two combination lifting lugs and support pads welded on all column sections. Lifting lugs and support brackets on each column section shall be capable of supporting the full weight of the pump assembly including the discharge head.

F. Discharge Head Assembly:

1. The horizontal discharge shall be located above the pump base and shall terminate with an ANSI standard flange. Coordinate with discharge piping for all new pump locations. Each pump discharge shall be drilled and tapped on top and both sides for 1" NPT connections for a pressure gauge connection and other appurtenances. Provide threaded plug for all connections. Provide 2-inch threaded outlet on discharge head base for air /vacuum valve. The 90° Bend shall be designed to minimize turbulence and headloss and shall consist of at least 3 mitre sections. Refer to pump column machining accuracy requirements for this fabrication. Stress relieve the discharge head prior to machining.
2. Pump base shall be designed to support the pump and driver and shall be rectangular of the size to bear on a pump supporting structure over the pump opening, or shall be round for mounting on the flange of a suction barrel, as appropriate. Provide stainless steel flange bolts and o-ring gasket to form a water-tight seal for suction barrel mounting. Design shall be suitable for 100 psi pressure without leakage or damage. A flat face gasket is not allowed.
3. Pump base shall be machined flat and perpendicular to the shaft centerline on the bottom and designed to support the pump and driver and attach to an appropriate sole plate. Machine flange faces to be parallel to within 0.005" TIR or Manufacturer's recommended tolerances, whichever is less. Machine motor, stuffing box, and column flange registers to be concentric to within 0.005" TIR or Manufacturer's recommended tolerances whichever is less. Stress relieve head fabrications with heat prior to machining.
4. For pumps mounted on a structural floor, provide a steel sole plate for anchoring to

the structure with appropriate size opening to remove the pump. Sole plate opening shall be sufficient size to allow complete pump removal without removing the sole plate. Pump base shall attach to the sole plate. Machine or mill the top surface of the sole plate flat. Provide air vent holes to allow a good grout pack through-out the plate bearing surface.

5. Furnish stainless steel anchor bolts for the pump sole plate and the pump brace at the lower pump floor. Jack bolt and nuts for pump brace shall be stainless steel.
6. The head shall contain a 1" pre-lubrication connection to wet down line shaft bearings before starting the pump.

G. Shaft Seal:

1. For open line shaft pumps, provide the discharge head with a renewable bronze bushing, ASTM B271, Alloy C93200, a replaceable stainless steel shaft sleeve keyed to the shaft with an O-ring seal between the shaft and the sleeve, and a shaft seal and ASTM A48 cast iron bleed-off style packing box with split bronze packing gland and bronze gland bolts. Provide NSF approved 5/8" minimum graphite impregnated aramid type fiber packing. Provide two sets of extra packing material for each pump.

H. Motor Stand:

1. Provide a motor stand above the pump base to support the motor above and the pump below. The motor stand may be an integral part of the pump base or a separate stand bolted to the pump base. Provide a motor stand with openings with heavy duty hinged stainless steel guard screens on opposite sides to permit access to the shaft seal, lubrication connections and shaft coupling. Machine the base plate bearing surface, stuffing box mounting surface, and motor flange surface parallel to one another and perpendicular to the shaft axis. Machine the column and stuffing box aligning registers concentric to one another and the shaft axis. Stress relieve the motor stand prior to final machining. Provide four heavy duty jack bolts on the motor stand for pump/motor shaft alignment purposes. Provide stainless steel bolts for bolting motor to motor stand.
2. Provide connections for the motor bearings cooling systems (if required). Provide pressure regulating or flow control valves. Field piping will be furnished and installed by others.
3. Provide 3/4-inch minimum drain connection and facilities to completely drain all packing discharge and all water which collects in the motor stand. Adequately slope motor base to drain so the water does not pond. Non-shrink grout may be used in the motor base to provide a sloped bottom.

I. Motor Coupling:

1. Motor to pump coupling for solid shaft motors shall be a three-piece rigid adjustable coupling for adjusting the impeller setting. Zinc plate or anodize the non-machined coupling parts to reduce corrosion. Provide aligning registers on mating surfaces on coupling components. Furnish all coupling bolts, nuts, washers and keys.

J. Pump Painting:

1. Paint the inside of column pipe and discharge head, outside of shaft tube, and outside

of bowls and column which is submerged or obscured from view, shall be coated with Epoxy, AWWA C-210, to give a minimum total dry field thickness of 15 mils. Other exposed surfaces shall be cleaned, primed, and painted with two (2) coats of manufacturers standard exterior machinery enamel. Furnish extra touch-up paint for installation Contractor's use.

2. Coat interior of pump bowls with a ceramic epoxy coating to enhance pump efficiency. Prepare surface to SSPC SP5 minimum, or as recommended by the coating manufacturer. Prime and finish coat shall be 10 mils each DFT Belzona 1341 or Chesterton ARC PW NSF efficiency enhancement coating system for potable water
3. Holiday test exterior coating using high voltage spark testing at a maximum voltage of 125 volts per mil. Wet sponge holiday testing will not be acceptable and correct all defects.

K. Suction Barrel

1. Suction barrels shall be welded steel construction with a flat bottom, cylindrical walls, inlet pipe and heavy flanged top. Top flange shall support the pump and motor and shall match the pump base. Furnish top O-ring gasket and stainless steel flange bolts, nuts and washers to anchor pump base and seal the connection. O-ring shall be suitable for 100 psi pressure. Provide connections in the suction barrel top as shown on plan sheets for air release valve outlet. Provide four lifting lugs below the floor level for setting barrels. The top surface of the suction barrel mounting flange shall be sufficiently flat to allow the Installation Contractor to level these surfaces within 0.002 in/ft. of diameter or the pump manufacturer's recommended tolerance, whichever is more stringent. The suction barrel mounting flange may be shipped loose for field leveling and welding. After installations, it is anticipated that the top flange will not be within 0.002 in/ft. diameter. If this is the case, then the manufacturer shall re-machine the top flange in the field to be within 0.002 in/ft. No exceptions. Pump supplier shall provide the structural design of the pump can to accommodate the forces and moments for the largest pump being supplied for the pump station with a minimum factor of safety of 3.0 applied. Design of the barrel flange and head mounting shall be the manufacturer's responsibility; however it is anticipated that the barrel flange will be drilled and tapped.
2. All barrels shall be the nominal diameter and of the length indicated in the pump setting schedule. The bottom and wall of the barrel shall be one 3/8" inch thick. Provide 3/8" vertical straightening vanes on the inside of the barrel from the bottom of the can to the general area of the suction inlet, to reduce pre-rotation as shown on plan sheets. The detailed design of the suction hydraulic pre-conditioning features shall be done by the pump manufacturer. Provide anchor rings on the outside of the barrel to anchor into the concrete encasement of the barrel. Provide leveling legs at the bottom of the barrel. Provide anchor bolts for leveling legs. As a minimum provide straightening vanes and vortex suppressors as shown in the Contract Drawings.
 - a. PAINT
 - 1). Exterior of barrel below the mounting flange shall be concrete encased bare steel. All other interior and exterior metal surfaces of suction barrel shall be coated with Epoxy, AWWA C-210, to give a minimum total dry field thickness of 15 mils. Other exposed surfaces shall be cleaned, primed, and painted with two

(2) coats of manufacturers standard exterior machinery enamel. Furnish extra touch-up paint for installation Contractor's use.

2). All metal surfaces shall be abrasively blasted to an SSPC SP5, white metal blast, and coated as specified. Where polyamide epoxy is required three coats shall be required. Between the prime coat and intermediate coat, apply a separate strip coat of polyamide epoxy on all angles, edges, welds, and bolted connections where coating film build will be reduced. Alternate color of each coat of epoxy with final color. Color shall be selected and approved by the Owner.

- 3). Final coating shall have a minimum dry film thickness of 12 mils and shall not exceed manufacturer's maximum film build recommendations.
- 4). Holiday test coating using high voltage spark testing at a maximum voltage of 125 volts per mil. Wet sponge holiday testing will not be acceptable.

L. Spare Parts

Item	Description	Quantity
13	Top Drive Shaft Sleeve	1
15	Packing, set	1
16	Column Flange Gasket	1
17A	Packing Box Bushing	1
*23	Lineshaft	1
26	Line Shaft Bearing, set	1
29	Line Shaft Sleeves, set	1
31	Coupling, Shaft, set	1
*32	Pump Shaft	1
34,35,41,50	Bowl Bearings, set	1
36W	Bowl Wear Ring, set	1
*38	Impeller, set	1
38A	Impeller Keys, set	1
38W	Impeller Wear Ring, set	1
39	Impeller Lock Collet, set	1

Notes:

- 1. Items marked by * are recommended only for severe duty or applications where down time is critical.

2.2 460 VOLT MOTORS

A. GENERAL

1. Motors shall be vertical, air cooled, solid shaft, copper wound stator, NEMA design B, random wound, copper bar rotor construction, squirrel cage induction type. Motors shall be of a premium efficiency design and inverter duty rated in accordance with NEMA MG-1, Part 31.
2. Horsepower nameplate rating of motor, at the 1.0 service factor, shall be equal to or greater than the total horsepower requirement of the pump when operating at any head between shutoff and minimum specified operating heads, including power requirements for bowl assembly, column and line shaft bearing loss, and motor thrust bearing loss from pump load. Motor shall have a service factor of 1.15 and shall be designed and manufactured in accordance with applicable provisions of the latest NEMA Standard Publication for Motors and Generators, MG-1 Part 20, subject to modifications and additions as herein set forth.
3. The locked rotor torque and breakdown torque shall not be less than shown in NEMA MG-1 20.10.
4. The locked rotor KVA/HP shall not exceed NEMA Code Letter G, 6.29KVA/HP.
5. Motor shall have a sound power level of no more than 85 dBA average at 1 meter (3.3 ft) distance when measured per IEEE Std. 85 "Test Procedure for Airborne Measurements on Rotating Electrical Machinery".
6. Rotor shall be "precision" balanced to within an amplitude peak to peak in accordance with the requirement of NEMA MG-1.
7. The rotor bars shall be swaged. The end rings shall be joined to the rotor bars by high frequency induction brazing. The rotor cores shall be held together by through-bolts and end plates.
8. The stator shall have all connections brazed with silver brazing alloy. The stator shall be braced and supported to eliminate any detrimental winding movement.
9. Motor shall be rated at 460 volts, 3-phase, 60 hertz.
10. Motor efficiency shall not be less than 92.6% and power factor not less than 85% uncorrected when operating at full load and rated voltage and frequency.
11. Motors shall be capable of bringing the pumps up to speed with a closed valve and 80% of rated voltage.
12. Motors shall be painted as specified in Section 09 96 00, PROTECTIVE COATINGS. The motor manufacturer's standard prime coating may be substituted for the specified prime coating if it is compatible with the final coat specified. The final coat shall be field-applied prior to installation.
13. The rotor bars shall be swaged for copper rotor bars. The end rings shall be joined to the rotor bars by high frequency induction brazing for copper rotor bars.

B. ENCLOSURE

1. Motor enclosure shall be Totally Enclosed Fan Cooled (TEFC) type in accordance with NEMA MG-1.

C. INSULATION

1. Motor windings shall be full Class F insulated. After stator assembly, the stator assembly shall be sealed vacuum-pressure impregnation (VPI) of epoxy resin. The stator shall receive two VPI treatments, each treatment consisting of a dip followed by an oven bake. After the final cure, the stator assembly shall receive a final (third) coating of a durable epoxy varnish to further protect against dust, moisture, and chemical degradation. The windings shall comply with the latest applicable provisions of NEMA MG 1, and end winding coils shall be braced to limit displacement to no more than 5.0 mils under any condition of starting or running.
2. Motor shall operate continuously at rated voltage and frequency at 50°C ambient temperature, with a temperature rise not to exceed both:
 - a. A Class B rise (70°C), per NEMA MG-1 20.8, measured by resistance at a 1.0 service factor when operating at 100% of the nameplate rated horsepower.
 - b. And a Class B rise (80 degrees C) per NEMA MG-1 20.8 measured by embedded detector (RTD) at a 1.0 service factor when operating at 100% of the nameplate rated horsepower.

D. BEARINGS

1. Motor bearings shall be designed for the maximum load imposed by the pump and motor, and shall be selected for a 5-year minimum life and a 25-year average life. Bearings shall be insulated as necessary to prevent shaft-bearing-frame current.
2. Motor bearings shall include 100ohm platinum RTD's.
3. Thrust bearing on top of motor shall be of anti-friction type with oil reservoir and other necessary appurtenances. Lower radial guide bearings shall be oil-lubricated, anti-friction or split-sleeve type bearing with oil reservoir or grease lubricated. Thrust bearing shall be of the air cooled type.
4. Upper bearing shall include an insulated bearing carrier and lower bearing shall include a shaft ground ring. If a third party installs the shaft grounding devices, the warranty of the motor shall not be voided or shortened.

E. MOTOR TERMINAL BOX

1. Motor terminal box shall be oversized to accept conductors and conduit as identified on the one-line diagrams without exceeding minimum bending radius per the National Electrical Code. Direct cable to cable connections shall not be permitted. Box shall be located 90° clockwise from the pump discharge. Bottom and front of box shall be removable. Terminal box shall receive motor cables from the bottom. Terminal box shall be adequately insulated to prevent excessive vibration.
2. Box shall be NEMA Type II.

F. ACCESSORIES TERMINAL BOXES

1. Motor shall have accessory leads from space heaters. Leads for space heaters shall be terminated on barrier type terminals with stainless steel screws. Leads shall be suitably marked and identified with heat shrink markers. Accessories terminal boxes shall be located on the same side as the motor terminal box with no overlapping. Accessories terminal boxes shall have stainless steel nameplates attached with stainless steel screws.

The nameplates shall say "SPACE HEATER". Accessories boxes shall be bottom or side entry and shall be sized to accept 2 #12, #12 Ground, 3/4" Conduit.

G. GROUNDING MEANS

1. Provide a grounding lug threaded into the motor frame within the motor terminal box and other motor conduit boxes. Lug shall be suitable for terminating #6 ground conductor. Lug shall be similar and equal to Burndy KC Servit. Provide two NEMA 2- hole ground pads located near the base of the motor mounted 180 degrees apart. Ground pads shall be stainless steel and suitable for terminating #4/0 ground conductor.

H. APPURTENANCES

1. All wires and electrical connections shall be copper. All wiring penetrating motor frame shall be protected against chaffing with a rubber grommet.
2. Space Heaters: Motor shall be equipped with space heaters rated for operation on 120 volt, 60 hertz, single-phase. They shall maintain the internal temperature above dew point when motor is not operating. Space heaters shall not be located directly in the access holes where they may pose a danger of burn or shock to servicemen. Space heater wiring shall be routed to prevent wire being between the frame and space heater.
3. All appurtenance boxes shall be laid out to avoid overlap and access limitation to the boxes. Appurtenance boxes shall be secured with stainless steel screws.
4. Motor windings shall include 2 RTD's per phase. RTD's shall be 100 ohm platinum.

I. DOCUMENTATION

1. Motor Manufacturer shall supply documentation for the motors as follows:
 - a. Letter of Compatibility: The VFD supplier (refer to Section 26 29 23.11, 480 VOLT VARIABLE FREQUENCY DRIVES) in conjunction with the pump/motor supplier shall issue a letter of compatibility stating that the VFD and motor are compatible.
 - b. Complete dimensional data including the following:
 - 1) dimensional outline drawings
 - 2) maintenance clearances
 - 3) locations and sizes of lubrication connections, vents, drains, etc.
 - 4) Complete nameplate data.
 - c. Allowable time periods between starts.
 - d. Subtransient reactance.
 - e. Speed-torque curve at 100% and 80% of rated voltage.
 - f. Speed-current curve at 100% and 80% of rated voltage.
 - g. Acceleration time at 100% and 80% of rated voltage.
 - h. Thermal damage curve (I^2t)
 - i. Locked rotor withstand time.
 - j. Rotor inertia.
 - k. Schematic and interconnection diagrams.
 - l. Bearing descriptions.
 - m. Motor weights.
 - n. Maximum kVAR allowed for power correction. Maximum allowed kVAR shall be included on the motor nameplate as well.
 - o. Results of tests.

- p. Measured locked rotor current and torque.
- q. Motor no load data (i.e. amps, power factor, etc.)
- r. Locked Rotor Power Factor
- s. Instruction manual.

Note: All documentation listed above shall be supplied with the motor's initial submittal with the exception of the motor test results and instruction manual, which shall be furnished later on in the project. Incomplete data will not be reviewed and submittal will be returned, "Not Approved, Revise and Resubmit".



U.S. ELECTRICAL MOTORS
 DIVISION OF EMERSON ELECTRIC CO.
 8100 WEST FLORISSANT AVE.
 P.O. BOX 3946 * BLDG. K * ST. LOUIS, MO 63138
 FAX (314) 553-1101



DATE: 9/25/02

P.O. NO.: A-2927
 USEM Order/Line NO.: 1123612 SO 100

TO: A&H Enterprises *
 1353 Milam Road
 Brownsville, TX, 78521
 ATTN: SILVANO ALMAYA

Model Number: NA
 Catalog Number: NA
 Titan VHS Weather Protected
 CONF_MOTOR.TITAN VHS WPI

REVISIONS:
 (NONE)

ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY US ELECTRICAL MOTORS.
 THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

Features:

HOLD PRODUCTION
 Horsepower 00150.00-00000.00 ~ KW: 111.9
 Enclosure WPII
 Poles 06-00 - RPM: 1200-0
 Frame Size H5006-P
 Phase/Frequency/Voltage.. 3-060-460 ~ Random Wound
 Service Factor 1.15
 Insulation Class Class "F" ~ VPI-2000
 Altitude In Feet (Max) .. 3300 Ft. (1000 M)
 Ambient In Degree C (Max) +40 C
 Efficiency Class Premium Efficiency
 Application Centrifugal Pump
 Customer Part Number
 Base Diameter (Inches) 24.5
 Coupling Size 1-15/16" Bore, 1/2" Key
 NRR/SRC/Bolted Coupling Non-Reverse Ratchet
 Steady Bushing Steady Bushing Not Requested
 Pricebook Thrust Value (lbs).. 11250
 Customer Down Thrust (lbs) ... 11250
 Customer Shutoff Thrust (lbs).
 Up Thrust (lbs)
 Inverter Duty Rating:
 Load Type (Base Hz & Below) .. Variable Torque
 Speed Range (Base Hz & Below). 10:1
 Temperature Rise (Sine Wave): "F" Rise @ SF (Resist)
 Starting Method Direct-On-Line Start
 Duty Cycle Continuous Duty
 Load Inertia (lb-ft²): NEMA ~ NEMA Inertia: 1718.00 - 1.00
 Number Of Starts Per Hour: NEMA
 Motor Type Code HUEI
 Rotor Inertia (LB-FT²) 124. LB-FT²
 Quantity of Bearings PE 1
 Quantity of Bearings SE 1
 Bearing Number PE 7226 BCB
 Bearing Number SE 6219-J



U.S. ELECTRICAL MOTORS
 DIVISION OF EMERSON ELECTRIC CO.
 8100 WEST FLORISSANT AVE.
 P.O. BOX 3946 * BLDG. K * ST. LOUIS, MO 63136
 FAX (314) 553-1101



DATE: 9/25/02

P.O. NO.: A-2927
USEM Order/Line 1123612 SO 100
NO.:

TO: A&H Enterprises *
 1353 Milam Road
 Brownsville, TX, 78521
ATTN:SILVANO ALMAYA

Model Number: NA
Catalog Number: NA
 Titan VHS Weather Protected
 CONF,MOTOR,TITAN VHS WPI

REVISIONS:
 (NONE)

**ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY US ELECTRICAL MOTORS.
 THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.**

Accessories:

- Direct Connected To Load
- Counter CW Rotation FODE
- Insul. Bearing - Upper Bracket
- 115 Volt Space Heaters
- Stainless Steel Hardware
- Bearing RTD-100 Ohm,3 Lead
- Both Bearings
- Winding RTD's-100 Ohm,3 Lead
- VFD Duty
- Q-1 Accessory Outlet Box - Same Side As Main O/B
- 1" NPT Conduit Opening
- One Box with Terminal Board
- Robertshaw 366A8 Vib. Switch
- Q-1 Upper/Short End Bracket
- Std. Mounting Position
- Q-1 Lower/Pulley End Bracket
- Std. Mounting Position

USE THE DATA PROVIDED BELOW TO SELECT THE APPROPRIATE DIMENSION PRINT

Horsepower	150
Pole(s)	06
Voltage(s)	460
Frame Size	5006P
Outlet Box AF	8.06
Outlet Box AA	3.50
Accessory Outlet Box DM	1

MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
NA	NA	3	HUEI	5006P

ORDER NO.	1123612	LINE NO.	100
-----------	---------	----------	-----

MPI:	75375
HP:	150
POLES:	6
VOLTS:	480
HZ:	60
SERVICE FACTOR:	1.15
EFFICIENCY (%):	
S.F.	94.8
FULL	95
3/4	95.7
1/2	95.4
1/4	92.9
POWER FACTOR (%):	
S.F.	87.3
FULL	87.7
3/4	87.2
1/2	83.7
1/4	69.1
NO LOAD	6.3
LOCKED ROTOR	21.2
AMPS:	
S.F.	195
FULL	169
3/4	126
1/2	88
1/4	55
NO LOAD	35.6
LOCKED ROTOR	1093.7
NEMA CODE LETTER	G
NEMA DESIGN LETTER	B
FULL LOAD RPM	1185
NEMA NOMINAL EFFICIENCY (%)	95
GUARANTEED EFFICIENCY (%)	94.1
MAX KVAR	24.1
AMBIENT (°C)	40
ALTITUDE (FASL)	3300
SAFE STALL TIME-HOT (SEC)	30
SOUND PRESSURE (DBA @ 1M)	81
TORQUES:	
BREAKDOWN(% F.L.)	242
LOCKED ROTOR(% F.L.)	96
FULL LOAD(LB-FT)	664.2

The Above Data is Typical. Sinewave Power Unless Noted Otherwise



U.S. ELECTRICAL MOTORS
DIVISION OF EMERSON ELECTRIC COMPANY
ST. LOUIS, MO



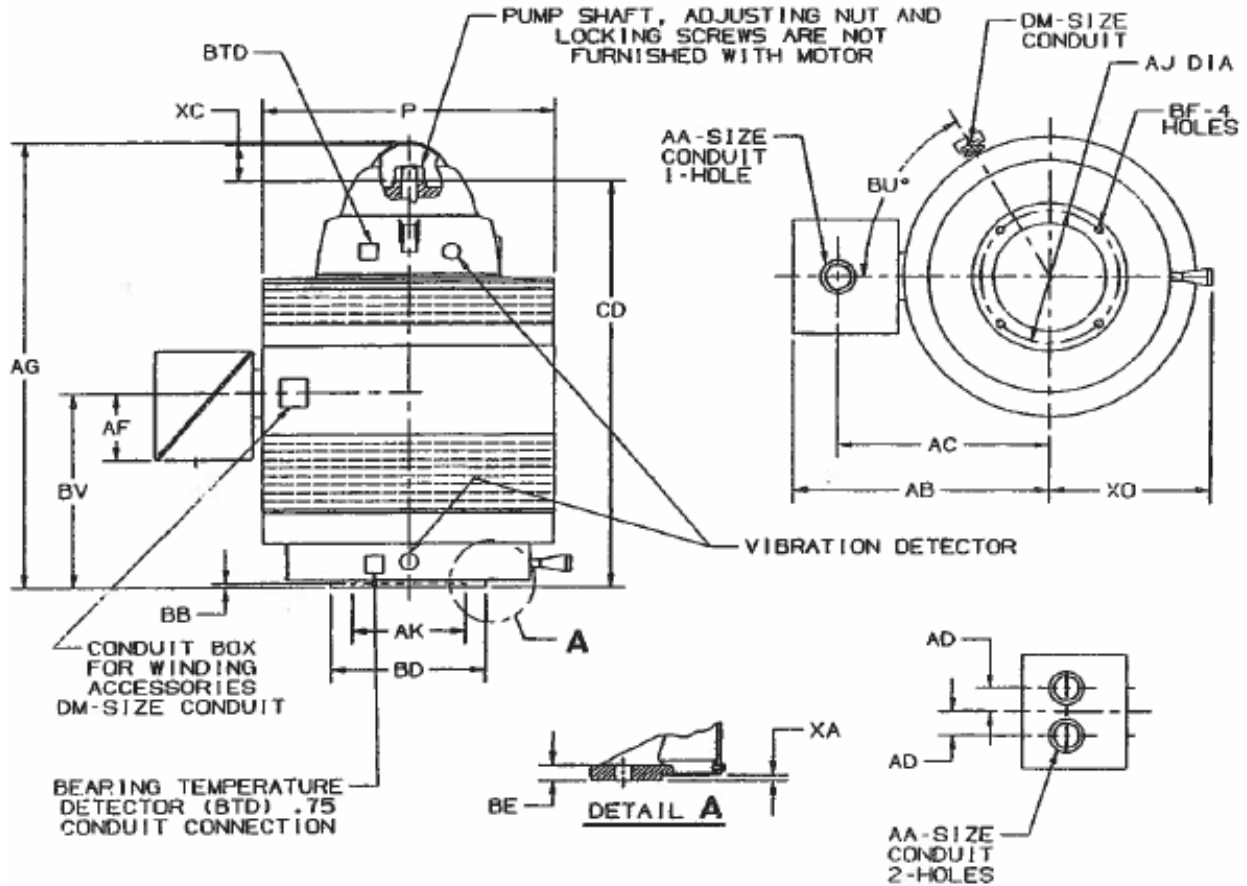
VERTICAL TURBINE PUMPS UNITS
11250-35

VERTICAL MOTORS

WEATHER PROTECTED TYPE 11
 FRAME: 5000P,PH
 TYPE: HU

PRINT: 09-1832-060
 EFFECTIVE: 29-MAY-01
 SUPERSEDES: NEW

SHEET 1 OF 1



ALL DIMENSIONS ARE IN INCHES

FRAME	P	AG	BV	CD	XC	XO
5006	42.25	56.31	19.38	49.75	6.25	24.75
5008		60.44		53.98		
5009		64.44	23.38	57.88		

FRAME	AJ	AK +.005	BB MTN	BD MAX	BE	BF	XA
5000P	14.750	13.500	.25	24.50	.88	.69	.13
5000PH				20.00			

FRAME	HP	VOLT	AA	AB	AC	AD	AF	BU	DM	
5000	ALL	460	3-1/2 NPT	32.68	27.18	N/A	8.06	65*	1 NPT	
	ALL	2300		33.68	28.19		10.00			
	ALL	4000		38.94	30.31		3.00			10.94
	ALL	ALL								

- ROUGH DIMENSIONS MAY VARY BY + .25" DUE TO CASTING AND OR FABRICATION VARIATIONS.
- CONDUIT OPENINGS MAY BE LOCATED IN STEPS OF 90°. STANDARD IS AS SHOWN WITH CONDUIT OPENING DOWN.

TOLERANCES	
FACE RUNOUT	.007 F.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBET	.007 F.I.R.
MAXIMUM SHAFT END PLAY	.010



U.S. ELECTRICAL MOTORS
 DIVISION OF EMERSON ELECTRIC CO.



DO NOT USE FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED

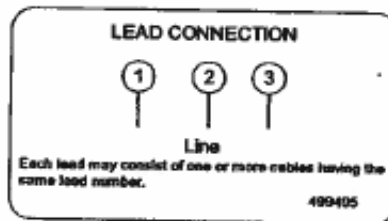
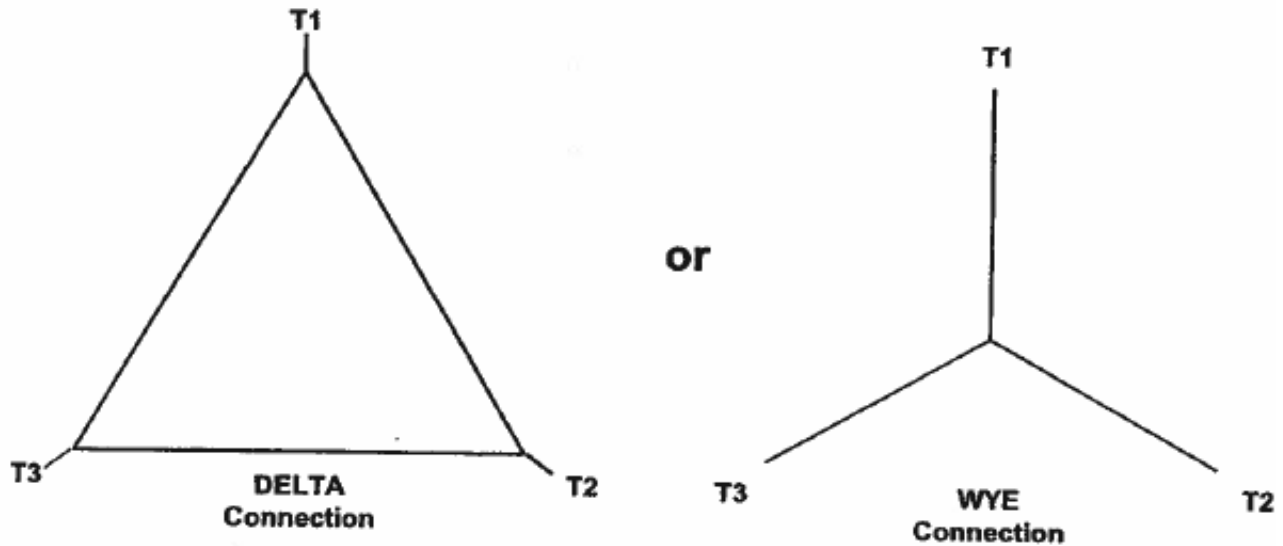
VERTICAL TURBINE PUMPS UNITS

11250-36



499495

Motor Wiring Diagram



To reverse direction of rotation interchange connections L1 and L2.

Each lead may be comprised of one or more cables.
Each cable will be marked with the appropriate lead number.

EFFECTIVE: 2/27/96
SUPERCEDES: X736618, 96441, 179879, 284138
Connection Plate: 499495
Connection Decal: 912113

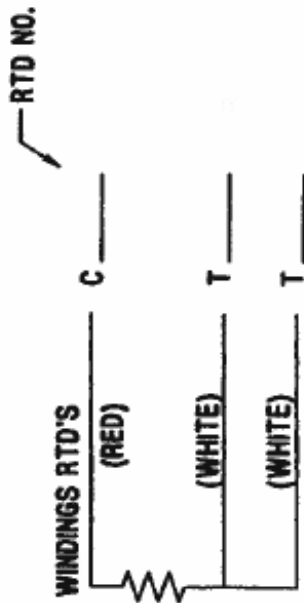
A 833989 A

WINDING RTD'S

1. THERE ARE QTY-6 RESISTANCE TYPE TEMPERATURE DETECTORS (RTD) INSTALLED IN THE STATOR WINDING, 2 PER PHASE. REFER TO NAMEPLATE ATTACHED TO THE MOTOR ADJACENT TO ACCESSORY OUTLET BOX FOR RATING THE RTD'S.

2. DETECTORS ARE INSTALLED IN PHASES AS SHOWN.

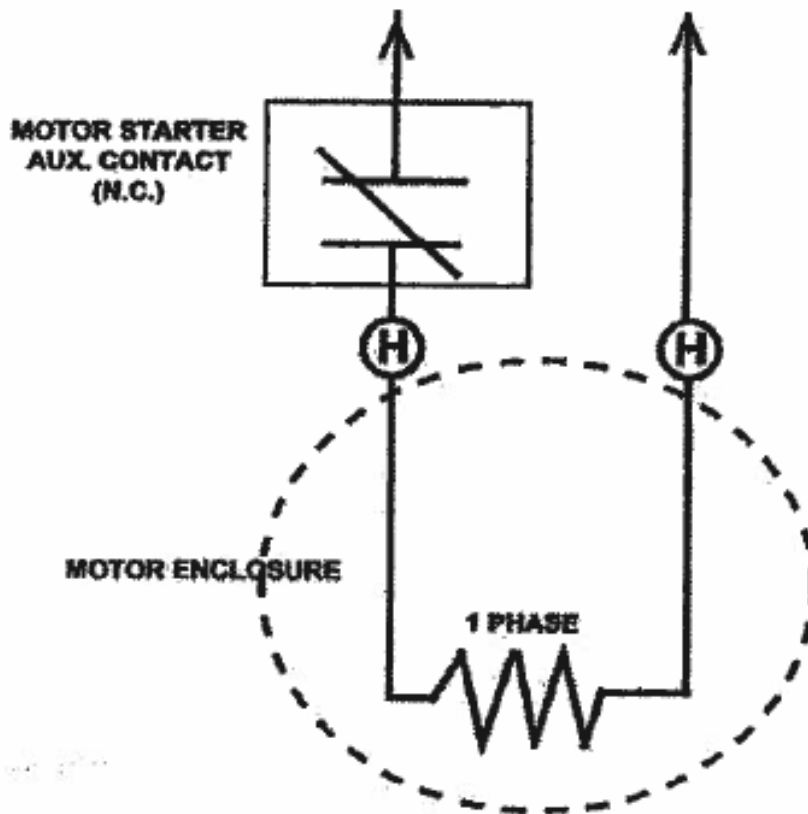
PHASE	A	B	C
RTD NO.	1, 11	2, 22	3, 33



ACCESSORY LISTING		QTY-6 3 LEAD RTD'S	
U.S. ELECTRICAL MOTORS DIVISION OF EMERSON ELECTRIC CO. ST. LOUIS, MISSOURI		CUSTOMER CONNECTION DIAGRAM	
DATE	DRWN 9-MAY-79, HEB	TYPE	---
REV	RVSJ 8-JUN-00, RHW	TYPE	---
APP	APPO 8-JUN-00, REP	TYPE	---
SCALE	NONE	TYPE	---
MATERIAL	---	TYPE	---
DESCRIPTION OF CHANGE	REDRAWN ON CAD 8-10-89	TYPE	---
MOD	6-JUN-00 UPDATED	TYPE	---
CDG	1 1 1 CDG	TYPE	---
CDG	A 833989	TYPE	---

SPACE HEATER CONNECTION DIAGRAM

SPACE HEATER LEADS MAY BE LOCATED IN EITHER THE MAIN OUTLET BOX OR IF SO EQUIPPED, AN AUXILIARY BOX



THIS EQUIPMENT IS SUPPLIED WITH ANTI-CONDENSATION HEATERS. HEATERS SHOULD BE ENERGIZED WHEN EQUIPMENT IS NOT OPERATING TO PROTECT UNIT BY PREVENTING INTERNAL CONDENSATION. CONNECT THE "H" OR HEATER LEADS TO	
115V VOLTS	288W WATTS RATING

SPACE HEATER NAMEPLATE (ON MOTOR)

SILICONE RUBBER SPACE HEATERS

Electric motors frequently have space heaters installed to prevent moisture condensation in the motor during times the motor is not running.

Many motor manufacturers use metallic or ceramic cartridge heaters for this purpose. Because such heaters are small they must operate at a high surface watt density and consequently high temperature. The high temperature causes rapid heater failure, often within the first year.

To combat this high failure rate, many smart users specify that space heaters are to be operated at one-half their rated voltage. This lowers the surface watt density to one-fourth the value with rated voltage, and increases the heater life more than proportionally.

U. S. Electrical Motors has another, better, solution to heater failure rate- the use of silicone rubber space heaters. The heaters are manufactured by sandwiching a resistance wire network between two pieces of high-temperature silicone rubber and bonding the silicone rubber pieces together. The silicone rubber heaters are designed for low surface watt density by providing a large surface area (a heater measuring 45" X 2.5" is rated at 169 watts, or 1.5 watts per square inch). In operation, the heaters are cool enough to touch with the bare hand without being burned. The life of these heaters typically exceeds the life of the motor.

Silicone rubber heaters enjoy another advantage over metallic or ceramic heaters. Because they are applied directly to the winding end turns, it is usually possible to achieve the required condensation prevention with a lower power consumption.

These silicone rubber heaters are used, when specified, on all U. S. Electrical Motors motors. It is not necessary for the user to specify operation at one-half rated voltage to get the long heater life that is desired.

* Space heaters must be operated at $\pm 10\%$ rated voltage to be effective.

DR# 587-9358
H.E. Barr
1/8/81
*Revision: 10/27/87
D. Linton

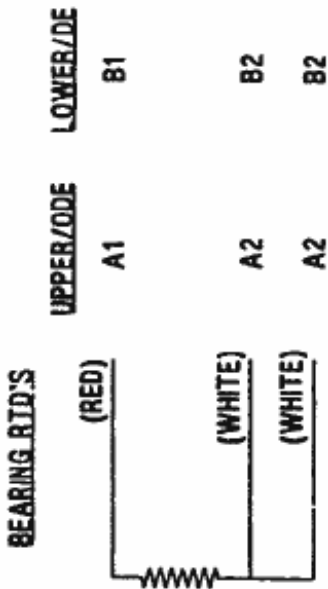
A 338312 A

BEARING RTD'S

1. THERE ARE QTY-1 OR 2 (3 LEAD) BEARING RTD'S INSTALLED,
ONE PER BEARING.

A = UPPER/ODE (OPPOSITE DRIVE END)

B = LOWER/DE (DRIVE END)



U.T. CHANGE LET NOTICE NO.	DESCRIPTION OF CHANGE	SCALE	UNITS	DATE	BY	REVISION
-	MOD 12-APR-00	NONE	IN	DRWN 12-APR-00, RAW		
A	MOD 11-JUL-00			RVSD 11-JUL-00, RWK		
				APPD 11-JUL-00, REP		
				MATERIAL		
				U.S. ELECTRICAL MOTORS DIVISION OF EMERSON ELECTRIC CO. ST. LOUIS, MISSOURI		
				QTY 1 OR 2 BEARING RTD'S (3 LEAD)		
				CUSTOMER CONNECTION DIAGRAM		
				ACCESSORY LISTING		
				CDG		
				A 338312 A		

Robertshaw

TENNESSEE

A SIEBE COMPANY

GENERAL DESCRIPTION

The Model 366 VIBRASWITCH is a vibration sensitive device that protects rotating and reciprocating machinery from extensive damage resulting from mechanical malfunction. When the vibration level of a VIBRASWITCH-protected machine exceeds normal by a preselected amount, an internal switch closes, actuating either an audible warning system or a shutdown circuit before costly damage occurs. Failing bearings, broken blades and similar malfunctions cause increased imbalance or high frequency vibration detectable with the VIBRASWITCH. It is designed for maintenance-free service in permanent installations where general purpose weather-resistant enclosures are required.

The VIBRASWITCH is an acceleration sensitive instrument that measures the total acceleratory shock present on the machine. Acceleration is a vibration characteristic of prime importance in cases of mechanical failure on reciprocating or rotating machinery. Acceleration is directly related to the shock forces (impact) acting on a machine — thus the VIBRASWITCH offers a valid measurement of the destructive forces acting on the machine.

Accelerator measurements made by the VIBRASWITCH are the summation of all of the individual accelerations giving a total destructive force acting on the machine — the result is positive protection.

PRINCIPLE OF OPERATION

The Model 366 VIBRASWITCH employs a magnetic circuit opposed by inertial and adjustable spring forces in the actuating mechanism. Operation of the VIBRASWITCH may be understood by reference to Figure 1.

The armature is constrained so as to respond to only one direction of movement by a frictionless flexure pivot composed of two overlapping blocks and a leaf spring loaded in one direction to hold the blocks together. The armature rotates on the pivot being forced in one direction by the adjusting spring force and the other direction by the magnetic force.

When the entire assembly is subjected to vibration perpendicular to the base, the peak acceleration times the effective mass of the armature produces an inertial force, aided by the adjustable spring tending to pull the armature away from the stop pin and the restraining force of the magnet. When peak acceleration exceeds the set-point level the armature leaves the stop pin, increasing the gap and decreasing the force with the armature continuing to move up until it reaches the latch magnet, actuating the switch during its upward travel.

The VIBRASWITCH may be reset by depressing the reset button or by applying power to the electrical reset coil. The effect of temperature in the mechanism is negligible as the elastic modulus of the adjusting spring and the magnetic flux through the air gap both decrease slightly with increasing temperature thereby compensating each other.

PRODUCT SPECIFICATION MODEL 366

VIBRASWITCH® MALFUNCTION DETECTOR Model 366

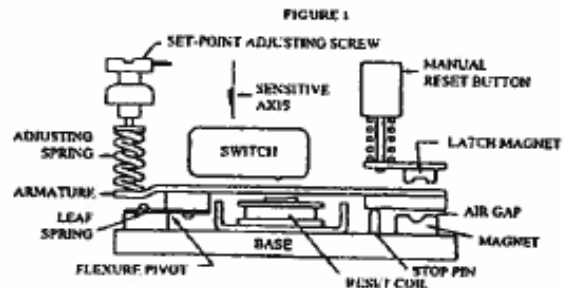


VIBRASWITCH MODEL 366



FEATURES AND BENEFITS

- **Acceleration sensitive —**
Measures total destructive shock, not displacement.
- **No maintenance —**
No moving parts except when set-point is exceeded.
- **Continuous protection —**
No attention required after installation.
- **Long life —**
Instrument is rugged and durable - no wearing parts.
- **Reset —**
Choice of remote electrical or manual at unit.
- **Self powered —**
Does not require any form of external power to operate.
- **SF Certified**



SPECIFICATIONS

Enclosure General purpose, meets weather resistant NEMA 4 specifications

Enclosure Materials

Cover High impact ABS thermoplastic
Base Type 360 (Cu Free) Aluminum
Setpoint Range 0-4.5g, adjustable 1 g per turn
Accuracy ± 5% of full range at frequencies up to 300 Hz.

Contact Ratings:

Designation "A" 7a max. 460 VAC max. non-inductive; 0.5a max. at 120 VDC; 1a max. at 48 VDC; 2a max. at 24 VDC.

Designation "D" 5 amps max. 240 VAC max.; 5 amps max. at 30 VDC.

Contact Arrangements SPDT or DPDT

Temperature Limits Maximum + 200°F.
 Minimum -40°F.

Reset Coil: Available in 24 VDC, 48 VDC, 120 VDC, 120 VAC @ 50/60 Hz, and 240 VAC @ 50/60 Hz.

Reset Coil Power 24 VDC, 0.5 amp
 48 VDC, 0.2 amp
 120 VDC, 0.14 amp
 120 VAC, 0.3 amp
 240 VAC, 0.3 amp

Weight:

Net 2 lbs.

Shipping 2.5 lbs.

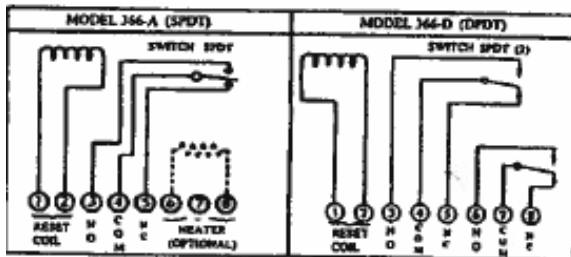
Accessory Equipment (optional)

Model 563A Vibration Monitor is available with "starting time delays" and "monitoring time delays" to prevent false shutdown or alarm conditions.

Related Product

Vibraswitches with built-in start and monitoring delays are available. See PS 375A/376A.

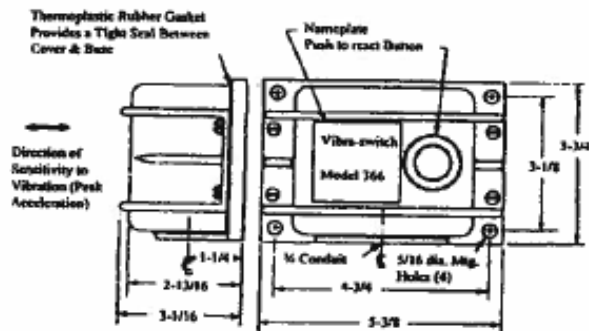
CUSTOMER CONNECTIONS



Robertshaw
 TENNESSEE
 A PERE COMPANY

U.S.A.
 Robertshaw Tennessee
 2318 Kingston Pike, S.W.
 P.O. Box 400
 Knoxville, TN 37901-0400
 Telephone: (423) 546-0550 Fax: (423) 544-5162
<http://www.industry.net/robertshaw-tennessee>.

DIMENSION DATA



ORDERING INFORMATION AND MODEL NUMBERS

* Standard Model 366 — A8

Key Model Number	
Desig.	Description
* 366	Vibraswitch® CSA Certified Enclosure 4 and 5 Equivilant: NEMA-4 & NEMA-12 Range: 0 - 4.5G

Table 1 - Switch Contacts

Desig.	Description
* A	SPDT Single pole, double throw load contacts.
D	DPDT (2 gang mounted SPDT load switches). See note below.

Table 2 - Remote Reset

Desig.	Description
0	No reset coil
2	24 volt DC reset coil voltage
** 3	240 volt AC reset coil voltage
4	48 volt DC reset coil voltage
7	120 volt DC reset coil voltage
* 8	120 volt AC reset coil voltage

** Not CSA Certified

Table 3 - Special Options

Desig.	Description
E	Base painted with gray epoxy paint (366)
H	Space heater installed for maintaining internal area of unit moisture free
EH	Base painted with gray epoxy paint and space heater installed (366)

Exports
 Robertshaw Controls Company
 International Operations
 2809 Emerywood Parkway
 P.O. Box 26344
 Richmond, Virginia 23261-6544
 Telephone: (804) 756-6500 Fax: (804) 756-6561

Canada
 Robertshaw Tennessee
 5785 Kennedy Road
 Mississauga, Ontario, Canada L4Z 2G3
 Telephone: (905) 890-5813 Fax: (905) 890-6098

Q-4132 (3/98)

Printed in U.S.A.

3.0 EXECUTION

3.1 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, the installation drawings for this project and applicable Installation Instructions of the Hydraulic Institute Standards
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 motors indoors and as recommended by the manufacturer, keeping bearings lubricated and the motor space heaters energized during storage and until they are put into service.
 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 welding, drain lines, gaskets, flange bolts, connecting piping, wiring, conduit, ducts, mounting brackets, anchors and other appurtenances as necessary.
 3. Certain items of equipment due to its size or character will be disassembled for shipping, and shall be assembled by the Construction Contractor as it is installed. It is the Contractor's responsibility, in establishing his costs for installation, to determine the degree of disassembly that the equipment will be shipped in.
- B. The Contractor shall schedule the service of the manufacturer to assist in the assembly, installation, lubrication, adjustment, and acceptance test of the equipment.

3.2 INSTALLATION

- A. Furnish and install sole plate anchor bolts and place non-shrink epoxy grout below the sole plates to be level within tolerances required by the manufacturer.
- B. Assemble the bowl assembly, column, line shaft and discharge head and anchor to sole plate.
- C. Set and align motor, assemble shaft coupling and adjust impeller setting. After running the pumping unit, readjust impeller.
- D. Furnish and install drain lines.
- E. Install the motor lubricating oil furnished by the vendor to the proper level.
- F. Set flow control valves as necessary.
- G. Furnish and install wiring, conductors, conduits, cable trays, and connections for motor leads, control wiring, etc.
- H. Conduct acceptance tests and submit an installation report as required in Paragraph 3.03.

3.3 FIELD QUALITY CONTROL

A. Acceptance Test:

1. Upon completion of installation of equipment, an acceptance test to verify the satisfactory installation and operation of the equipment shall be conducted by the Installation Contractor and Vendor. The test shall be conducted in a manner approved by and in the presence of the Engineer and Owner. Equipment shall be checked for excessive noise, alignment, vibration, and lateral deflection, general performance, etc. Vibration of the installed unit shall meet the requirements of Section 2.01. The unit must perform in a manner acceptable to the Engineer before the Owner will make final acceptance. A minimum of 30 days of satisfactory operation will be required prior to final acceptance. The Vendor shall provide testing equipment.
2. A field "bump" test of the installed pump and motor shall be made by the Vendor to confirm that the Reed Frequency is not within 15 percent of any operational exciting frequency.

B. 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, vibrations, noise, deflection, and motor bearing temperatures, as applicable.
2. The Vendor shall furnish calibrated testing devices to measure setting, alignment, noise, and vibration of the pump. Vibration data shall be recorded with a Vibscanner as manufactured by Pruftechnik, or approved equal.

C. Equipment Installation Report

The pump and motor representatives shall each submit a written report certifying the equipment is properly installed, lubricated, is in accurate alignment, is free from undue stress from connecting appurtenances, that it has been operated under all operating conditions, and that it is operating satisfactorily.

3.4 PAINTING

- A. Touch-up all damage of painting of the pumping unit with extra paint furnished by the manufacturer.

3.5 PRELIMINARY OPERATIONAL TEST AND SYSTEM OPERATIONAL TEST

- A. The Installation Contractor shall perform preliminary operational tests over a period of not less than two 10-hour tests or one 24-hour test. Data shall be recorded, such as wet well levels, pump discharge pressure, pump speed, flow rates, vibration, power information, etc.
- B. The equipment Vendor shall be responsible for operating the equipment and recording and submitting the necessary data from this test. The Installation Contractor shall assist in the performance testing.
- C. The cost of power required for performing all tests will be borne by the Owner. Testing will begin only after the wet wells are filled to their design levels. The Installation Contractor shall coordinate filling procedures with the Engineer.
- D. After the preliminary operational test is completed, and when all pump station and pipeline construction is complete and prior to final acceptance of the equipment, the pump station

Installation Contractor shall cooperate in performing an overall 30 day system operational test. The Owner will be responsible for operating the equipment and recording the data during this test. The Installation Contractor and his vendors will be responsible for troubleshooting and adjustments to the equipment. This 30 day system operational test is not required as part of substantial completion of the contract. The purpose of the test is to demonstrate or check the ability of the system to pump continuously with various pump combinations and speeds.

E. The Owner will bear the power costs for the System Operational Test.

F. It is anticipated that the 30 day system operational testing may begin after work is completed by other contractors. However, no guarantee is made by the Engineer or Owner as to the date for starting testing. If testing cannot begin as a sole result of delays in completion of work by other contractors, the Contractor will be granted an extension of time. No additional compensation will be provided to the Contractor as a result of delays in completion due to postponement of testing.

3.6 TRAINING

A. The manufacturer shall provide training per specification section 01 75 00 "Starting and Adjusting."

END OF SECTION

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - G E N E R A L

1.1 SUMMARY

- A. Basic mechanical requirements specifically applicable to Division 15 Sections, in addition to Division 1 - General Requirements.

1.2 REFERENCES

- A. ANSI: American National Standards Institute.
- B. ARI: American Refrigeration Institute.
- C. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers.
- D. ASME: American Society for Mechanical Engineers.
- E. ASTM: American Society for Testing and Materials.
- F. AWWA: American Water Works Association.
- G. MSS: Manufacturer's Standardization Society of the Valve and Fitting Industry.
- H. NEMA: National Electrical Manufacturers' Association.
- I. NFPA: National Fire Protection Association.
- J. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- K. UL: Underwriters' Laboratories, Inc.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01330 - Submittal Procedures.
- B. Submittals as specified in individual sections.
- C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- D. Mark dimensions and values in units to match those specified.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable local, state, and federal codes and regulations.
- B. Fire Protection: Conform to National Fire Prevention Association Code.
- C. Plumbing: Conform to National Plumbing Code.
- D. Conform to ASME B31.3 Process Piping Guide.
- E. Conform to The Chlorine Institute Pamphlet 94 Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Storage Equipment and Piping Systems, of latest edition.

- F. Obtain permits, and request inspections from authority having jurisdiction on of this Project.

1.5 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of the Owner before proceeding.

1.6 SEQUENCING AND SCHEDULING

Not Used

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE AND CAST IRON AND DUCTILE IRON FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes furnishing ductile iron piping three inches and larger for buried and exposed systems. Soil pipe and fittings are specified in other Specification Sections.

1.02 RELATED REQUIREMENTS

- A. Soil pipe and fittings not under this Specification Section.
- B. PLANS show pipe class, thickness class, type joints, and service pressure.
- C. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B18.2.1 Square and Hex Bolts and Screws (Inch Series)
 - b. ANSI B18.2.2 Square and Hex Nuts (Inch Series)
 - 2. American Society For Testing And Materials (ASTM)
 - a. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 3. American Water Works Association (AWWA)
 - a. AWWAC104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
 - b. AWWAC105, Polyethylene Encasement for Ductile Iron Pipe Systems
 - c. AWWAC110, Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-inch (75 mm
 - d. Through 1200 mm), for Water and Other Liquids
 - e. AWWAC111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - f. AWWAC115, Flanged Ductile-Iron Pipe with Threaded Flanges
 - g. AWWAC150, Thickness Design of Ductile-Iron Pipe
 - h. AWWAC151, Ductile-Iron Pipe, Centrifugally Cast, for Water

1.04 SUBMITTALS

- A. Furnish in accordance with Specification Section 01300, "Submittals". In addition to the items specified in Section 01300 "Submittals", furnish the following:
 - 1. Detailed installation drawings for piping.
 - 2. Manufacturer's descriptive literature for mechanical couplings, mechanical flange adapters, and restrained flange adapters.
 - 3. Certified test reports for threaded-on flanged pipe in for shop testing required.

4. Certification per Paragraph 1.05.

1.05 QUALITY ASSURANCE

A. Certification:

1. Pipe used in domestic water distribution systems to have Underwriters' label and be acceptable to local and state authorities without penalty.
2. Furnish sworn statement that inspection and all tests have been made and meet the requirements of AWWA C151.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping:

1. Piping with flanged ends to be protected with blank wooden or fiberboard flange protectors. Backing flanges are to be secured to the pipe ends.
2. Pipe spools to be loaded and blocked and lagged as necessary to ensure protection against damage during shipping.
3. Loose parts (couplings, nuts and bolts, gaskets, etc.) are to be shipped in crates that are clearly marked as to contents.

B. Handling and Unloading:

1. Unload and handle piping in accordance with pipe manufacturer's instructions.
2. Transfer of pipe to be accomplished utilizing nylon straps or steel cables.
3. Exercise extra care when handling flanged pieces due to the additional loads imparted by the flanges. (Insert blocking or other means to support the flanges independently of the pipe to prevent the weight of the flange from distorting the pipe.)
4. Maintain plugs and flange protectors in openings to protect the pipe.
5. Do not dump piping off of transport vehicle. Any damaged, chipped, or cracked fittings or pipe to be replaced at CONTRACTOR's expense.

C. Storage:

1. Store in an area that will avoid damage due to traffic.
2. Exposure to normal weather conditions is acceptable; however, avoid contact with other materials.
3. Store at job site on 4" x 4" blocking at 6' spacing. Piping may be stacked a maximum of three rows high as long as 4" high spacers are used on 6' centers.
4. Keep interior of piping free of all foreign matter.

1.07 MEASUREMENT AND PAYMENT

- A. Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part

PART 2 - PRODUCTS

2.01 MANUFACTURER(S)

A. Pipe:

1. American Cast Iron Pipe Co.
2. McWane Incorporated

DUCTILE IRON PIPE AND CAST IRON AND DUCTILE IRON FITTINGS

3. U.S. Pipe & Foundry

B. Fittings:

1. American Cast Iron Pipe Co.
2. McWane Incorporated
3. U.S. Pipe & Foundry Co.
4. Tyler Pipe
5. Griffin Pipe

2.02 MATERIALS AND/OR EQUIPMENT

A. General: Fabrication dimensions and accuracy of fabrication are responsibility of CONTRACTOR.

B. Pipe:

1. Ductile Iron: Per AWWA C151.
2. Thickness Class:
 - a. Aboveground Lines: As shown on PLANS and minimum for flanged pipe per AWWA C115, Table 15.2.
 - b. Underground Lines: As shown on PLANS, but not less than that indicated within AWWA C150 for internal pressure and depth shown on PLANS.

C. Fittings, Flanges, and Joint Material:

1. Fittings: Per AWWA C110 and C111.
2. Threaded-On Flanges: Per AWWA C115. Use ductile flanges on ductile fittings and cast iron flanges on cast iron fittings.
3. Nonflanged Joint Material
 - a. Rubber Gaskets for Water and Sewage Service: Per AWWA C111.
 - b. Rubber Gaskets for Diffused Air Systems (10 psi and 210°F Service): EPDM.

D. Restrained Joints:

1. Restrained Joint Pipe:
 - a. Pipes 16" and less: Joints to be restrained by Mega-Lug, by EBAA Iron, Inc. or equal by Ford Meter Box Co. Provide Mega-Lug Series 1100 and mechanical joint pipe and fittings, or equal by Ford Meter Box Co. Provide Mega-Lug Series 1700, or equal by Ford Meter Box Co. for push on joints.
 - b. Pipes greater than 16": Provide one of the following joint restraint systems:
 - 1) Flex-ring or Lock ring by American Cast Iron Pipe Co.
 - 2) TR Flex by U.S. Pipe Co.
 - 3) Super-Lock by Clow Corp
 - 4) Approved equal; locking gaskets not allowed.

E. Gaskets:

1. For water and sewage, use rubber gasket conforming to the Appendix in AWWA C115.
2. For air service, use 1/8-inch full-face EPDM gaskets, factory cut and conforming to AWWA C111.

F. Bolts and Nuts:

1. Aboveground:
 - a. Hex head bolts and nuts:
 - 1) Bolts per ANSI B18.2.1.
 - 2) Nuts per ANSI B18.2.2.
 - b. Number, size, and length per Table 15.2 of AWWA C115.
 - c. Material: Low carbon steel per ASTM A307.
 - d. Use studs with nuts on each end for pipe sizes 54" and larger.
 2. Underground:
 - a. Tee-head bolts and hexagonal nuts per AWWA C111.
 - b. Number, size, and length per Table 11.1 of AWWA C111.
 - c. Material: Low alloy steel or high strength cast iron in accordance with AWWAC111.
- G. Exterior Coating:
1. Buried Pipe and Fittings: Bituminous coated, not less than 1 mil thick.
 2. Exposed Pipe and Fittings: Reference Section 09902 "Painting and Projective Coatings" for coating requirements. Bituminous coated pipe and fittings will not be allowed.
- H. Interior Lining (pipe and fittings):
1. Air Service: Unlined.
 2. Water Service: Cement mortar lined per AWWA C104/A21.4.
 3. Sewage Service:
 - a. Interior lining for ductile iron sewer pipe to conform to manufacturer's recommendations.
 - b. Minimum lining thickness to be 40 mils regardless of material recommended.
 - c. Acceptable lining materials are:
 - 1) "Corropipe II Wasteliner" by Madison Chemical Industries.
 - 2) "Polythane" by Madison Chemical Industries.
 - 3) "Protecto 401" ceramic epoxy by Vulcan Group.
 - 4) "SP-2000W" by Superior Environmental Products.
 - 5) "SewPerCoat" by La Farge Calcium Aluminates.
- I. Encasement: Polyethylene encasement in accordance with AWWA C105.
- J. Mechanical Couplings: Dresser Style 38, long sleeve unless shown otherwise; equivalent by Smith-Blair or Baker. Harness when required for thrust restraint.
- K. Flanged Coupling Adapters: Dresser Style 127 (2"-12"), Dresser Style 128 (14"-96"), equivalent by Smith Blair or equal.
- L. Restrained Flanged Coupling Adapters: EBAA Iron Series 2100 or equal by Ford Meter Box Co.
- M. Wall Pipes: Unless otherwise shown on PLANS, wall pipes to be cast or ductile iron with an intermediate wall collar. End connections to be as shown on PLANS.

2.03 FABRICATION

- A. Flanged Pipe
1. Threaded-On Flanged Pipe:

DUCTILE IRON PIPE AND CAST IRON AND DUCTILE IRON FITTINGS

2. Shop thread, machine tight, and face in machine shop equipped for this type work and conforming to the requirements of AWWA C115.

2.04 SOURCE QUALITY CONTROL

- A. Threaded-On Flanged Pipe: Shop test, hydrostatically, each flanged pipe piece at 150 psig.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

- A. Installation: Per applicable Specification Section.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 15090
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe support and anchor systems.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 1 - General Requirements.
 - 3. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ANVIL International (ANVIL).
 - 2. American Society of Mechanical Engineers (ASME):
 - a. B31.1, Power Piping.
 - b. B31.3, Process Piping.
 - 3. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
 - d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - 4. American Welding Society (AWS):
 - a. D1.1, Structural Welding Code - Steel.
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. SP-69, Pipe Hangers and Supports - Selection and Application.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 01330 for requirements for the mechanics and administration of the submittal process. The final design of pipe supports is the responsibility of the Contractor and shall be certified by a licensed Professional Engineer of the State of Texas. Pipe support layouts shown on the drawings are schematic in nature and may be utilized by the Contractor as part of the Contractor-designed support systems.
 - 2. Product technical data including:

- a. Acknowledgement that products submitted meet requirements of standards referenced.
- b. Manufacturer's installation instructions.
- c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
- d. Scale drawings showing guides, hangers, supports, anchors, structural members and appurtenances to describe the pipe support system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

- A. Hanger Rods:
 1. Material:
 - a. ASTM A36.
 - b. ASTM A575, Grade M1020.
 - c. ASTM A576, Grade 1020.
 - d. Minimum allowable tensile stress of 12,000 psi at 650 DegF per MSS SP-58.
 2. Continuously threaded.
 3. Electro-galvanized or cadmium plated after threads are cut.
 4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

- B. Hangers:
 1. Hangers for use directly on copper pipe: Copper or cadmium plated.
 2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
 3. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and	ANVIL Figure 108 with Figure

All except noted	less Over 4 IN	114 ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82

- C. Concrete Inserts for Hanger Rods:
1. Continuous slots: Unistrut #P1000.
 2. Individual inserts: ANVIL Figure 281.
 3. Self-drilling expansion anchors: Phillips flush-end or snap-off end type.
- D. Beam Clamps for Hanger Rods:
1. Heavy duty.
 2. ANVIL Figure 134.
- E. Trapeze Hangers for Suspended Piping:
1. Material: Steel.
 2. Galvanized.
 3. Angles, channels, or other structural shapes.
 4. Curved roller surfaces at support point corresponding with type of hanger required.
- F. Vertical Pipe Supports:
1. At base of riser.
 2. Lateral movement:
 - a. Clamps or brackets
- G. Expanding Pipe Supports:
1. Spring hanger type.
 2. MSS SP-58.
- H. Pipe Support Saddle:
1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
 2. ANVIL Figure 264.
- I. Pipe Support Risers:
1. Schedule 40 pipe.
 2. Galvanized.
 3. As recommended by saddle manufacturer.
- J. Pipe Support Base Plate:
1. 4 IN larger than support.
 2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
 3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
 4. Collar welded to floor plate.
 5. Edges ground smooth.
 6. Assembly hot dipped galvanized after fabrication.
- K. Pipe Covering Protection Saddle:

1. For insulated pipe at point of support.
 2. ANVIL Figure 167, Type B.
- L. Wall Brackets:
1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
 2. ANVIL Figure 199.
- M. Pipe Anchors:
1. For locations shown on the Drawings.
 2. 1/4 IN steel plate construction.
 3. Hot dipped galvanized after fabrication.
 4. Designed to prevent movement of pipe at point of attachment.
- N. Pipe Guides:
1. For locations on both sides on each expansion joint or loop.
 2. To ensure proper alignment of expanding or contracting pipe.
 3. ANVIL Figure 256.

2.3 DESIGN REQUIREMENTS

- A. Supports capable of supporting the pipe for all service and testing conditions.
1. Provide 5 to 1 safety factor.
- B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- C. Design supports and hangers to allow for proper pitch of pipes.
- D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
1. ASME B31.3.
 2. MSS SP-58 and MSS SP-69.
 3. Except where modified by this Specification.
- E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
1. ASME B31.1.
 2. MSS SP-58 and MSS SP-69.
- F. Check all physical clearances between piping, support system and structure.
1. Provide for vertical adjustment after erection.
- G. Support vertical pipe runs in pipe chases at base of riser.
1. Support pipes for lateral movement with clamps or brackets.
- H. Place hangers on outside of pipe insulation.
1. Use a pipe covering protection saddle for insulated pipe at support point.
 2. Insulated piping 1-1/2 IN and less: Provide a 9 IN length of 9 LB density fiberglass insulation at saddle.
 3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of 9 LB density fiberglass insulation on saddle.

- I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.
- J. Pipe Support Spacing:
 - 1. General:
 - a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
 - b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
 - c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
 - 2. Steel, stainless steel, cast-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

- 3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

- 4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 DegF.

- 5. Support each length and every fitting:
 - a. Bell and spigot piping:
 - 1) At least one (1) hanger.
 - 2) Applied at bell.
 - b. Mechanical coupling joints:
 - 1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
- 6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.

7. Provide continuous support for nylon tubing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
 1. Included in this requirement are movements from:
 - a. Trap discharge.
 - b. Water hammer.
 - c. Similar internal forces.
- B. Weld Supports:
 1. AWS D1.1.
 2. Weld anchors to pipe in accordance with ASME B31.3.
- C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
- D. Inspect hangers for:
 1. Design offset.
 2. Adequacy of clearance for piping and supports in the hot and cold positions.
 3. Guides to permit movement without binding.
 4. Adequacy of anchors.
- E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.
- F. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
 1. Install concrete inserts as concrete forms are installed.
- G. Welding:
 1. Welding rods: ASTM and AWS standards.
 2. Integral attachments:
 - a. Include welded-on ears, shoes, plates and angle clips.
 - b. Ensure material for integral attachments is of good weldable quality.
 3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

- H. Field Painting:
 - 1. Comply with Section 09905.

3.4 HORIZONTAL MOVEMENT

- A. Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- B. Where horizontal pipe movement is greater than 1/2 inch (12.7 mm), offset pipe hanger and support so that rod hanger is vertical in hot position.

3.5 FINAL ADJUSTMENT

- A. Adjust Hangers and Supports:
 - 1. Ensure that rod is vertical under operating conditions.
 - 2. Equalize loads.
- B. Adjustable Clevis:
 - 1. Tighten hanger load nut securely to ensure proper hanger performance.
 - 2. Tighten upper nut after adjustment.
- C. C-Clamps:
 - 1. Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- D. Beam Clamps:
 - 1. Tighten all set screws and lock nuts.
 - 2. Hammer jaw firmly against underside of beam for Figure 127 only.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 15100
GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section provides requirements for furnishing and installing piping for facilities. Refer to related work specified in other sections to coordinate the complete installation.

- B. All piping is identified on the drawings by its size and service. Unless noted otherwise, pipe, fittings, and general purpose valves shall conform to those specified in the piping system specification sheet for that service. The piping system specification sheets are in alphabetical order at the end of this section. All special valves and other appurtenances shall be as specified herein.

1.02 RELATED WORK

- A. Division 1 – General
- B. Division 2 - Site Construction
- C. Division 5 – Metals
- D. Division 9 – Finishes
- E. Division 11 - Equipment

1.03 PROJECT RECORD DOCUMENTS

- A. Upon completion of all work, furnish prints and tracings showing locations and principal details and modifications of piping systems as built.

- B. Furnish all information on buried piping and utilities encountered during construction. Update the plan developed for the site at the onset of the project, with this information so the Owner has a complete record at the conclusion of this job.

1.04 SUBMITTALS

- A. Submit product data and shop drawings on each type of pipe, valves, fittings, fabricated piping, miscellaneous appurtenances, and accessories in accordance with Section 01300.

1.05 WELDERS CERTIFICATION

- A. Employ welders qualified by current certification in the positions required, to

perform welding operations per American Welding Society, *AWS Standard for Certification AWS Certified Welders*, requirements. Contractor shall submit documentation for all welders on the job, all welders who have had certification provided are to be employed by the contractor at the time of certificate submission. In the event that a welder leaves the employment of the contractor then the contractor shall make notification of the same and present the work information and certificate of the replacement employee, if the former employee is to be replaced on this project.

PART 2 - PRODUCTS

2.01 PIPING

All newly installed pipes and related products must conform to ANSI/NSI Standard 61 and must be certified by an organization associated with ANSI.

- A. Ductile Iron Pipe
 - 1. Ductile iron pipe shall conform to the requirements of section 13615.
- B. Cast Iron Pipe
 - 1. Cast iron pipe shall conform to CL 22, AWWA C 106 (ANSI A21.6).
 - 2. Pipes 3 inches and larger shall be cement lined in accordance with AWWA C 104 (ANSI A 21.4).
- C. Steel Pipe
 - 1. Black steel pipe for pressure less than 150 psi ambient temperatures shall be ASTM A 53 (ANSI B 125.1) or ASTM A 135 (ANSI B 125.3), grade B seamless (smaller than 24 inches) or electric-resistance welded (for 24-inch and larger) black steel or hot dipped galvanized standard weight unless otherwise noted.
 - 2. Stainless steel pipe shall be ASTM A 312 (ANSI 8135), Grade TP 304L seamless and welded stainless pipe.
- D. Polyvinyl Chloride Pipe (PVC)
 - 1. PVC pipe shall conform to the requirements of section 13625.
 - 2. All PVC pipe shall be manufactured from virgin plastic.
- E. Reinforced Concrete Culvert Pipe
 - 1. All reinforced concrete pipe to be used for culverts shall comply with ASTM C76, Class III.
- F. Fiberglass Reinforced Pipe
 - 1. All fiberglass reinforced pipe shall conform to the requirements of section 13700.

G. Copper tubing

1. All copper tubing for water service lines shall be type "K" and shall conform to ASTM Standard "Seamless Copper Water Tube" 81785, latest revision.

2.02 UNIONS

A. Malleable Iron Unions

1. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping 2-1/2 inches and larger. Use service galvanized unions for galvanized pipe. Use insulating unions where indicated or required where joining dissimilar metals.

B. Polyvinyl Chloride (PVC) Unions

1. Use Schedule 80 threaded PVC unions.

2.03 GASKETS

- A. Provide gaskets shall be manufactured by Garlock Sealing Technologies, and are NSF 61 approved for use with drinking water for all piping systems except the sewer lines, unless otherwise noted. Gaskets shall be applied with the proper material, so the Garlock STRESS SAVER XP shall be used with fiberglass reinforced pipe, and Garlock GYLOIN Style 3505 shall be used with ductile Iron pipe. Alternatives to these gaskets may be approved with engineers' approval prior to the bid. All submissions must have current NSF 61 approvals.

- B. Provide full face gaskets or flat faced and ring gaskets for raised face flanges. Use 1/16 inch thick gaskets for pipe and smaller than 6 inches and 1/8 inch thick gaskets for pipe 6 inches and larger. Gasket dimension shall conform to ANS I B16.21.

- C. Provide insulating flange gasket kit where indicated or required where joining dissimilar metals or pipe materials.

2.04 VALVES

- A. Valves shall be as specified in the plans or specification sheets, or as specified herein.
- B. All valves except those which are equipped with power operations shall be provided with manual operators. Unless otherwise specified, each manual

operator shall be equipped with an operating wheel.

- C. Chain wheels and operating chains shall be provided on all valves 4 " and larger with centerline more than 7' 6 " above the floor except where other operator types are specifically required. Each chain wheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without " gagging" of the wheel and will also permit reasonable side pull on the chain. Operating chains shall be heavily plated with zinc or cadmium and shall be looped to extend to within 4 ft. of the floor below the valve. Where recommended by the manufacturer, the operator shall be provided with a hammer blow wheel.
- D. Wrench nuts shall be provided on all buried valves, which are to be operated through floor boxes, and where shown. All wrench nuts shall comply with Section 20 of AWWA C500. Not less than two operating keys shall be provided for operation of the wrench nut operated valves.
- E. For all valves buried at a depth of greater than 3 ft., an extension stem shall be provided to bring the operating nut within 3 ft. of the finished elevation.

2.05 VALVE MARKING

- A. All exposed valves shall be tagged as per section 13610.

2.06 BACKFLOW PREVENTERS

- A. Backflow preventers shall be of the reduced pressure principal type conforming to the applicable requirements of AWWA C506 and shall be as manufactured by Cla-Val Company, WATIS, or equal as approved by the engineer.

2.07 VALVE BOXES

- A. Cast iron valve boxes extending to the finished or established ground or paved surfaces shall be provided for all buried valves. They shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Boxes shall be of the screw or sliding type having 5-1/4" shaft diameter or greater. Covers shall be marked with the class of service. A concrete pad 1' 6" x 1' 6" x 4" thick shall be poured around all valve boxes.

2.08 FREEZE PROTECTION

- A. Where specified on the plans, exposed piping, valves, or equipment shall be provided with freeze protection. The freeze protection shall consist of copper sheath,

resistance type heating cable and 1" of insulation. The heating cable shall be designed to keep the contained fluid 50 degrees F. above ambient temperature. The heating cable shall be suitable for 1 10-volt, single phase operation and ON-OFF switches for the tape shall be provided at each area of piping or equipment. The insulation shall be performed insulation oversized to allow for the heating cable.

2.09 14 HOSE BIBB

- A. Hose bibbs shall be of heavy duty NSF 61 certified brass body construction for W' threaded hose connection. Gland packing shall be Teflon polyflon, graphite, or rubber. Handle shall be zinc T handle with stainless steel screw. Hose bibb shall be made by aquiline or approved equal.

PART 3 - COATINGS AND LININGS

3.01 GENERAL

- A. Coatings and linings are specified on the piping system shall be as specified in 09900.

3.02 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement for all buried cast or ductile iron pipe, fittings, and valve shall conform to AWWA C105 (ANSI A2 1.5).

3.03 EXTRUDED PLASTIC COATING

- A. Extruded plastic coating for steel pipe shall be a high density polyethylene, or polypropylene copolymer, extruded to cover an adhesive first coat, to form a combined adhesive-extruded thermoplastic resin coating conforming to Federal Specification L-C 5308, Type 1. The first coat shall consist of rubber, asphalt, fluxing oil, and high molecular weight resin. Extruded plastic coatings shall have a minimum combined thickness of adhesive and thermoplastic of 33 mils for pipe and up to and including 2 " nominal diameter, 37 mils up to 3 ", 42 mils up to 5 ", and 46 mils for all pipe larger than 5 " nominal diameter. Joints, for pipe and fittings having extruded plastic coating, shall be covered by plastic sleeves fabricated from radiation cross-linked, semi-rigid polyethylene, coated on the inside with a specifically formulated thixotropic adhesive, which when heated, shall shrink to encapsulate the joint with a strong imperious seal.

3.04 GALVANIZING

- A. Galvanizing shall be in accordance with ASTM A 153.

3.05 PIPE SUPPORTS

- A. All exposed piping shall be supported as indicated on the contract drawings.

PART 4 - EXECUTION

4.01 PIPE LAYOUT AND INSTALLATION

A. Layout and Preparation

1. Make piping layout and installation as shown on the plan documents, but also taking into consideration the most advantageous use of headroom, valve access, opening and equipment clearance and clearance for other work. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance.
2. Do not cut or weaken any structural member.
3. Cut pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs to full inside diameter.
4. All wall penetrations will be wall pipes, if not shown as passing through a sleeve. Either the wall pipe or sleeve at the penetration will be cast in place.

B. Installation

1. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending is prohibited. Make all connections to equipment using flanged joints, unions or grooved coupled joints. Make reducing connections with reducing fittings only.
2. Install all other pipe according to manufacturer's recommendations using the recommended tools.

C. Handling

1. Handle pipe, fittings and accessories in a manner that will ensure their installation in the work in sound, undamaged condition. In unloading, reloading, hauling and laying pipe and fittings, use proper equipment, tools and methods to prevent damage. Hooks inserted in ends of pipe must have broad, well-padded contact surfaces.

D. Cutting Pipe

1. Perform cutting of cast iron pipe in a neat manner, without damage to pipe or to the cement lining. Cut pipe smooth, straight and at right angles to

pipe axis with mechanical pipe cutters. In locations where use of mechanical cutters would be difficult or impractical, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut pipe without damaging impact or shock.

E. Cleaning

1. Clean interior of all pipe and fittings thoroughly of all foreign matter before installing and keep clean until the work has been accepted. Remove all lumps, blisters and excess coating from exterior spigot and interior bell surfaces. Wire brush such surfaces and wipe clean and dry, free from oil and grease, before placing spigot into bell. Keep joint contact surfaces clean until joining is completed. Take every precaution to prevent foreign material from entering pipe while it is being installed. Do not place debris, tools, clothing or other materials in pipe.

F. Laying Pipe

1. Protect pipe from lateral displacement by means of pipe embedment material installed as provided in trench backfill specification.
2. Do not under any circumstances lay pipe in water or in unsuitable weather or trench conditions.
3. Lay pipe with bell ends facing direction of laying except when making closures.
4. Trenching and pipe laying shall be uniformly in a straight line and to uniform elevation unless otherwise specified on plans. Lay pipe on bedding as specified in the section on Excavation, Trenching and Backfilling for Utilities, as required in individual pipe material specification.
5. Excavate trenching for underground piping to the required depth to ensure 3 1/2 feet minimum cover over the pipe unless otherwise indicated on the drawings. Excavation and backfill shall be performed in accordance with Division 2. Where pipe is installed beneath railroad tracks, there shall be a minimum vertical distance of 4 feet inches from the top of pipe to top of railroad ties. Construction clearance to cross under railroad track will be obtained from Railroad Authority by the OWNER. Any expense of bracing or supports to tracks during excavation operation beneath track shall be considered part of the contract. Where pipe is installed beneath State Highways, there shall be a minimum vertical distance of 4 feet from top of pipe to top of paving at center line of highway, or 2 feet from top of pipe to bottom of ditch (if existing), whichever is greater. In special locations, Highway Department may require additional cover. Construction clearance and other requirements to cross under State Highways shall be obtained by the

OWNER.

6. Before placing pipe into the trench, the outside of the spigot and the inside of the bell shall be wiped clean and dry, free from oil and grease. Every precaution shall be taken to prevent foreign material from entering the pipe. During layout operation, no debris, tools, clothing or other material shall be placed into the pipe. After placing a length of pipe in the trench, the spigot end shall be centered in the bell, the pipe forced home, brought to the correct alignment and covered with an approved backfill material. Metallic tape shall be buried above pipe at a depth of 24 inches below finished grade for location purposes. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a water tight plug or other approved means. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

G. Plastic Pipe

1. Installation shall be in accordance with applicable ASTM Standards D 2774, D 2855 and F 402. The CONTRACTOR shall make certain before jointing polyvinyl chloride pipe that the ring groove in the bell of the pipe is clean, with no dirt or foreign material that could interfere with proper seating of the ring. Make sure pipe end is clean. Wipe with a clean dry cloth around the entire circumference from the end to one inch beyond the reference mark. Lubricate the spigot end of the pipe, using only the lubricant supplied by the manufacturer. Be sure the entire circumference is covered. The coating should be the equivalent of a brush coat of enamel paint. It can be applied by hand, cloth, pad, sponge or glove. Do not lubricate the ring groove in the bell because such lubrication could cause ring displacement. The level end is then inserted into the bell so that it is in contact with the ring. Brace the bell, while the level end is pushed in under the ring, so that previously completed joints in the line will not be closed up. The spigot end is pushed until the reference mark on the spigot end is flush with the end of the bell.

If undue resistance to inserting of the level end is encountered or the reference mark does not reach the flush position, disassemble the joint and check the position of the ring. If it is twisted or pushed out of its seat, clean the ring, bell and level end and repeat the assembly steps.

4.02 PIPE JOINT INSTALLATION

A. Dissimilar Materials

1. Make joints between dissimilar metal pipe and equipment using insulating unions or insulating flange gasket assembly. Joints between above-ground piping and below- ground piping are to be considered the same as dissimilar

metal pipe.

C. Screwed Joints

1. Make up all threaded joints using a suitable joint lubricating compound applied to male threads only. Thoroughly ream all field cuts and carefully make all connections so that thread engagement will be secured.

D. Welded Joints

1. Weld and fabricate piping in accordance with ANSI Standard B31.1, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to acceptable standards.
2. Align piping and equipment so that no part is offset more than 1/15 inch. Set all fittings and joint square and true preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
3. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the procedure as the completed weld. Otherwise, remove tack welds during welding operation.
4. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
5. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

E. Flanged Joints

1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical pre-stressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal, or north-south center line.
2. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Secure with a suitable gasket cement.
3. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets.
4. Take special care when attaching suction and discharge piping to jumping equipment to ensure that no stresses are transmitted or imposed on pump suction and discharge flanges by the connected piping. Install and permanently

support all such piping to accurately match bolt holes and to provide uniform contact over entire installation of bolts in flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while bolts in pump connection flanges are tightened.

4.03 WET CONNECTIONS

Schedules of existing fittings and proposed new fittings needed to make wet connections to existing waterlines as shown on the plans are estimates only. It is to be recognized that after existing lines and fittings are uncovered, that some discrepancies may occur. Where discrepancies occur, the CONTRACTOR shall request a decision by the OWNER as to how the connection in question shall be made. CONTRACTOR shall plan his work concerning wet connections in such a way that a minimum of inconvenience shall occur to existing water customers due to water service interruptions. Before water service interruptions are made to any customer, CONTRACTOR shall notify designated official and cooperate with operating personnel in every way to minimize service interruptions due to wet conditions. In certain locations, other utility lines or conduits will be obstructing the normal path of proposed waterlines. In such instances, gravity lines of all kinds hold priority as to grade over water pressure lines, gas lines, electric conduits, or other obstruct ion conduits or combinations of conduits which may be encountered. CONTRACTOR is to analyze conditions carefully and then use best judgment in determining proper method of proceeding through obstructed area with waterline construction, and shall notify the PUB forty-eight (48) hours in advance of making such connection after obtaining approval from the engineer.

4.04 OFFSET AND FITTINGS INSTALLATION

- A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.
- B. Provide proper space for covering and removal of pipe, and special clearances for offsets and fittings.
- C. All iron fittings shall be wrapped in a plastic protector in conformance with AWWA Standard C 105 and ANSIA21.5 "Polyethylene Encasement for Gray and Ductile Cast Iron piping for Water and Other Liquids." Fitting wrapping shall be installed in such a manner as to curtail or prevent corrosion of the metallic fittings.

4.05 SECURING AND SUPPORTING

- A. General

1. Support piping as required to maintain line and grade, with due provisions for expansion and contraction. Use approved hangers, rollers, anchors and guides properly connected to structural members. Do not support piping from other piping. Use non-metallic and 316 stainless steel hangers.
- B. Hangers and Straps
1. Place hangers not more than 6 feet apart on 1/2-inch and 3/4-inch pipes or 10 feet apart on larger pipes. Place hangers not more than 6 feet apart for all sizes of PVC pipe.
 2. Support vertical risers with hot-dipped galvanized steel strap pipe clamps properly supported at every floor unless otherwise shown on drawings.
 3. Perforated bar hangers, straps, wires or chains are not permitted.
- C. Unistrut Pipe Supports
1. Provide standard Unistrut metal framing members and appurtenances for pipe support when applicable. Mult-A-Frame and Power-Strut pipe support systems also are acceptable. All Unistrut and appurtenances shall be 316 SS unless otherwise noted on the drawings.
- D. Anchors
1. Provide anchors as indicated or required. Unless otherwise detailed on drawings, use pipe anchors consisting of heavy steel collars with lugs and bolts for clamping to pipe and attaching anchor braces. Install anchor braces in the most effective manner to secure desired results.
 2. Do not install supports, anchors or similar devices where they will damage construction during installation or because of the weight or the expansion of the pipe.
- E. Pipe Guides
1. For plant piping, provide pipe alignment guides as required by pipe manufacturer.
 2. Guide expansion joints with two guides on the side opposite the anchor.
- F. Trench Installation
1. Where in trench, provide fittings with concrete thrust blocking between fitting and solid undisturbed ground in each case except where solid ground blocking

support is not available. At tops of slopes, anchor vertical angle bends by means of a mass of concrete of sufficient weight to resist hydraulic thrust at maximum pressures to which pipe will be subjected. Install concrete blocking and anchors so that all joints between pipe and fittings are accessible for repair. Bearing area of concrete reaction blocking against ground or trench bank shall be as shown on drawings or as directed by Engineer in each case. In event that adequate support against undisturbed ground cannot be obtained, install metal harness anchorages consisting of steel rods or bolts across joint and securely anchor to pipe and fitting or other adequate anchorage facilities approved by Engineer to provide necessary support. Should lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, entire cost of furnishing and installing metal harness anchorage in excess of contract value of concrete blocking replaced by such anchorages shall be borne by Contractor.

3. Locations other than trenches

Provide blocking, struts, anchorages or other supports for fittings installed in fills or other unstable reaction ground above grade or exposed within structures as required by drawings or as directed by Engineer

4. Protection of Metal Surfaces

Adequately protect all steel clamps, rods, bolts and other metal accessories used in reaction anchorages, or joint harness subject to submergence or contact with earth or fill material and not encased in concrete from corrosion with not less than two coats of either Koppers " Bitumastic No.50 ", or equal, heavy coal-tar coating material applied to clean, dry metal surfaces. First coat shall be dry and hard before second coat is applied. Paint metal surfaces exposed above grade or within structures with two coats (in addition to a primer coat) of a paint in accordance with Division 9 - Finishes.

4.06 PIPING SLEEVES

A. Sleeves

1. Wall pipes are required where shown on the plans and at all pipes penetrating water holding structures.
2. Fit with sleeves all pipes passing through masonry and concrete construction. Fabricate sleeves of hot dipped galvanized steel pipe unless otherwise indicated. Size sleeve for minimum clearance between pipe or insulation and sleeve.
3. Extend each sleeve through the floor or wall. Cut the sleeve flush with

each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.

4. Caulk all sleeves watertight and airtight. Seal annular space between pipes and sleeves with a Thunderline Link-Seal or equal.

B. ISOLATION VALVES, DRAIN VALVES AND INSTRUMENT TAPS

i. Isolation Valves

- a. Provide piping systems with line-size shutoff valves located at the risers, at main branch connections to mains for all equipment, and at other locations as indicated and required by contract drawings.

j. Drain Valves

- a. For plant services, install drain valves where shown on contract drawings.

k. Instrument Taps

- a. Instrument Taps for Liquid Process Service. Provide 3/4 inch size tap process pipe branch connection as specified above with 3/4 inch nipple terminated with a 3/4 inch shutoff valve. The nipple and shutoff valve shall be as specified in the individual piping material specifications.
- b. Location of instrument taps shall be generally as shown on piping drawings.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 15122
PIPE COUPLINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Bolted, split-sleeve coupling.
 2. Bolted, split-sleeve flange adapter coupling.
 3. Dismantling joints.
 4. Flanged coupling adapters.
 5. Flexible couplings.
 6. Restrained flange coupling adapters.
 7. Grooved joint couplings.

1.02 REFERENCES

- A. American National Standards Institute/National Science Foundation (ANSI/NSF).
1. 61 - Drinking Water System Components - Health Effects.
- B. American Society for Testing and Materials (ASTM):
1. A 36 - Standard Specification for Carbon Structural Steel.
 2. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dip, Zinc-Coated, Welded and Seamless.
 3. A 193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.
 4. A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSC Minimum Tensile Strength.
 5. A 536 - Standard Specification for Ductile Iron Castings.
 6. A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
 7. A 576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 8. D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
 9. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- C. American Water Works Association (AWWA):
1. C111 - AWWA Standard for Rubber Gasket Joints for Ductile Iron Pipe and Fittings.
 2. C207 - AWWA Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100mm through 3,600mm).
 3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe

4. C227-AWWA Standard for Bolted, Split-Sleeve Restrained and Non restrained Couplings for Plain-End Pipe.
5. C606 - AWWA Standard for Grooved and Shouldered Joints.

1.03 SUBMITTALS

- A. Shop drawings, detailing dimensions, and materials.
- B. Piping Layout Drawings: Coordinate preparation of required piping layout drawings such that coupling center sleeve sizes are clearly identified on drawings.
- C. Manufacturer's published installation instructions.

PART 2 - PRODUCTS

2.01 PIPE COUPLINGS FOR DUCTILE IRON PIPING

- A. Dismantling Joints:
 1. Manufacturers: One of the following or equal:
 - a. Romac Industries, Inc., Style DJ400.
 - b. Smith-Blair, Inc., Series 975.
 2. Materials:
 - a. Flanged Spool:
 - 1) C207 Schedule 40 steel pipe in accordance with ASTM A 53 for sizes 3 inches to 12 inches.
 - 2) Steel for pipe in accordance with ASTM A 36 for sizes 14 inches to 72 inches.
 - b. End Ring and Body:
 - 1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A 536.
 - 2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A 36 or A 53.
 - c. Follower Ring: Ductile iron in accordance with ASTM A 536 or steel in accordance with ASTM A 36 or A 576.
 - d. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
 - e. Tie Rods: High tensile steel in accordance with ASTM A 193 Grade B7.
 3. Flange Design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
 4. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.
- B. Flanged Coupling Adapters: 12 inch size and smaller.
 1. Manufacturers: One of the following or equal:
 - a. Dresser, Inc., Style 227.

- b. Romac Industries, Inc., Style FCA501.
 - c. Smith-Blair, Inc., Series 912.
2. Materials:
 - a. Flanged Body: Ductile iron in accordance with ASTM A 536.
 - b. Follower Ring: Ductile iron in accordance with ASTM A 536.
 - c. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
 3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
 4. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.
- C. Flanged Coupling Adapters: Greater than 12 inch size:
1. Manufacturers: One of the following or equal:
 - a. Dresser, Inc., Style 128-W.
 - b. Romac Industries, Inc., Style FC400.
 - c. Smith-Blair, Inc., Series 913.
 - d. Victaulic Depend-O-Lok, Style FxE
 2. Materials:
 - a. Flange and Flanged Body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
 - b. Follower Ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
 - c. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
 3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
 4. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.
- D. Flexible Couplings:
1. Manufacturers: One of the following or equal:
 - a. Dresser, Inc., Style 253.
 - b. Romac Industries, Inc., Style 501.
 - c. Smith-Blair, Inc., Series 441.
 - d. Victaulic Depend-O-Lok, Style ExE.
 2. Materials:
 - a. Center Rings: Ductile iron in accordance with ASTM A 536.
 - b. Follower Rings: Ductile iron in accordance with ASTM A 536.
 - c. Bolts and Hex Nuts:

- 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
- 2) Buried and Underwater: Type 316 stainless steel in accordance with ASTM F 593.
3. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.
4. Center Sleeve Dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Size	Sleeve Length
3 inch and smaller	Manufacturer's standard
4 inch through 8 inch	7 inches
10 inch through 14 inch	12 inches
Greater than 16 inch	Use steel flexible coupling per Paragraph 2.2

E. Restrained Flange Coupling Adapter:

1. Manufacturers: One of the following or equal:
 - a. Romac Industries, Inc., Style RFCA.
 - b. Victaulic Depend-O-Lok, Style FxF
2. Materials:
 - a. Flange and Flanged Body: Ductile iron in accordance with ASTM A 536.
 - b. Follower Ring: Lug type restraint system.
 - 1) Follower Ring: Ductile iron in accordance with ASTM A 536.
 - 2) Restraining Lugs: Ductile iron in accordance with ASTM A 536.
 - a) Designed to contact the pipe and apply forces evenly.
 - 3) Restraining Bolts: Ductile iron in accordance with ASTM A 536. Bolt heads shall be designed to twist off when the proper torque has been applied.
 - c. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.

5. Angular Deflection: Restrained flange coupling adapter must allow angular deflection after assembly.
- F. Grooved Joint Couplings:
1. Manufacturers: One of the following or approved equal:
 - a. Victaulic Company, Series 31.
 2. Materials:
 - a. Housings: Ductile iron in accordance with ASTM A536.
 - b. Gaskets: FlushSeal type, or equal, elastomer in accordance with ASTM D2000.
 - c. Bolts and Nuts: Electroplated steel in accordance with ASTM A449.
 - d. Coating: Manufacturer's standard:
 - 1) Orange enamel.
 - 2) Coal tar epoxy.
 - 3) Organic zinc primer.
 - 4) Bituminous
 3. For use with rigid or flexible radius grooved components in accordance with AWWA C606.
 4. For connection to IPS steel pipe sizes, Victaulic Style 307, or approved equal.

2.02 PIPE COUPLINGS FOR STEEL PIPING

- A. Bolted, Split-Sleeve Couplings:
1. Split-sleeve type pipe coupling with double arch cross section. Coupling shall be designed to close around the pipe ends, confining the gaskets beneath the arches of the sleeve. A water-tight, axial seal is created by tightening the bolts to pull the coupling against the outside wall of the pipe.
 2. Coatings: Couplings shall be epoxy-coated on the inner diameter and outer diameter prior to delivery. Buried couplings shall receive additional protection against corrosion that matches the pipe as specified in Section 09905.
 3. Couplings: Wall thickness that is adequate for the test pressure.
 - a. Provide split-sleeve type coupling in a shouldered, an "expansion x expansion" configuration where indicated on the Drawings.
 - b. Where restrained pipe joints are required or are indicated on the Drawings, provide split sleeve type coupling in a "fixed x fixed" configuration. Coordinate with coupling manufacturer pipe supplier to provide restraint rings on pipe.
 - c. Where axial pipe expansion must be accommodated or where they are indicated on the Drawings, provide split-sleeve type coupling in a "fixed x expansion" configuration. Coordinate with coupling manufacturer and pipe supplier to provide restraint ring on fixed side of coupling.
 - d. Axial Restraint and Angular Deflection:

- 1) Where axial restraint is required to resist pipe thrust and angular deflection is required to provide flexibility in the piping or where they are indicated on the Drawings, provide split-sleeve type coupling in a "fixed x fixed modified" configuration.
- 2) Install coupling with full 1-1/2-inch manufacturer's recommended gap between ends of piping with the shoulders of coupling bearing on the inner restraint rings that are welded to the piping at both ends of coupling.
- 3) Coupling shall be designed for an angular deflection of not less than the angular deflection indicated in the following table unless a larger angular deflection is indicated on the Drawings.

Nominal Pipe Diameter	Allowable Angular Deflection
18 inch and smaller	3 degrees
20 inch	2.5 degrees
24 inch	2 degrees
30 inch	1.75 degrees
36 inch	1.5 degrees
42 inch	1.25 degrees
48 and 54 inch	1 degree
60 inch	0.875 degrees
66 and 72 inch	0.75 degrees

4. Restraint Rings: Provide where required to create a restrained joint. Coordinate with piping manufacturer. Shop fabricate pipe with restraint rings that engage the interior edge of the coupling shoulder.
 - a. Weld for restraint ring: Suitable for test pressures.
 - b. Gaskets: The sealing members are comprised of 2 "O" ring gaskets. Internal pressure shall not be required to affect the seal. For water service, the gasket supplied shall be Isoprene or Buna-N in accordance with ASTM D 2000 for design pressure within temperature range of minus 20 to 180 degrees Fahrenheit. Elastomers shall have properties in accordance with ASTM D 2000.
5. Manufacturers: One of the following or equal:
 - a. "Expansion x Expansion" Configuration:
 - 1) Victaulic, Depend-O-Lok, E x E, Type 2 Coupling.
 - b. "Fixed x Expansion" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x E, Type 2 Coupling.
 - c. "Fixed x Fixed" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x F, Type 2 Coupling.
 - d. "Fixed x Fixed Modified" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x F, Type 2 Modified Restrained Coupling.
6. Materials:
 - a. Couplings: Steel in accordance with ASTM A 36.

- b. Bolts and Nuts: In accordance with ASTM A 325 and ASTM A 563 194.
- 7. Pipe Preparation: Pipe ends shall be smooth for expansion or contraction requirements. Where thrust restraint is required or is indicated on the Drawings, pipe ends shall include restraint rings affixed for pipe end restraint requirements. The coupling manufacturer shall provide restraint rings that shall be shop welded to the pipe in accordance with the manufacturer's requirements. Follow coupling manufacturer's recommendation for size and amount of welding required to attach the restraint rings to the pipe.

B. Bolted, Split-Sleeve Flanged Adapter Couplings:

- 1. Flanged adapter with split-sleeve type coupling with double arch cross section. Coupling shall be designed to confine the gaskets beneath the arches of the sleeve. A water-tight, axial seal is created by tightening the bolts to pull the coupling together and seat the gaskets against the outside wall of the pipe and adapter.
- 2. Coatings: Couplings shall be epoxy-coated on the inner diameter and outer diameter prior to delivery. Buried couplings shall receive additional protection against corrosion that matches the pipe as given in Section 15061.
- 3. Couplings: Wall thickness that is adequate for the test pressure.
 - a. Provide coupling in a "flanged x expansion" configuration where indicated on the Drawings.
 - b. Where axial pipe movement must be restrained, provide coupling in a "flanged x fixed" configuration. Coordinate with pipe supplier to provide restraint ring on fixed side of coupling.
 - c. Where axial restraint is required to resist pipe thrust and angular deflection is required to provide flexibility in the piping, provide sleeve type coupling in a "flanged fixed x fixed modified" configuration. Install coupling with full 1-1/2-inch gap between ends of pipe with shoulder of coupling bearing on ring welded to pipe at both ends of coupling.
- 4. Restraint Rings: Provide where required to create a restrained joint. Coordinate with piping manufacturer. Shop fabricate pipe with restraint rings that engages the interior edge of the coupling shoulder.
 - a. Weld for restraint ring: Suitable for test pressures as specified in the Pipe Schedule as specified in Section 15061.
- 5. Gaskets: The sealing members are comprised of 2 "O" ring gaskets. Internal pressure shall not be required to affect the seal. For water service, the gasket supplied shall be Isoprene or Buna-N in accordance with ASTM D 2000 for design pressure within temperature range of minus 20 to 180 degrees Fahrenheit. Elastomers shall have properties in accordance with ASTM D 2000.
- 6. Manufacturers: One of the following or equal:
 - a. "Flanged x Expansion" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x E, Type 2 Flanged Adapter Coupling.
 - b. "Flanged x Fixed" Configuration:

- 1) Victaulic, Depend-O-Lok, F x F, Type 2 Flanged Adapter Coupling.
 - c. “Flanged x Fixed Modified” Configuration:
 - 1) Victaulic, Depend-O-Lok, F x F, Type 2 Modified, Flange Adapter Coupling
 - 7. Materials:
 - a. Couplings: Steel in accordance with ASTM A 36.
 - b. Bolts and Nuts: In accordance with ASTM A 325 and ASTM A 563.
 - 8. Pipe Preparation: Pipe ends shall be smooth for expansion or contraction requirements. Where thrust restraint is required or is indicated on the Drawings, pipe ends shall include restraint rings affixed for pipe end restraint requirements. The coupling manufacturer shall provide restraint rings that shall be shop welded to the pipe in accordance with the manufacturer’s requirements. Follow coupling manufacturer’s recommendation for size and amount of welding required to attach the restraint rings to the pipe.
- C. Dismantling Joints:
- 1. Manufacturers: One of the following or equal:
 - a. Romac Industries, Inc., Style DJ400.
 - b. Smith-Blair, Inc., Series 975.
 - 2. Materials:
 - a. Flanged Spool:
 - 1) C207 Schedule 40 pipe in accordance with ASTM A 53 for sizes 3 inches to 12 inches.
 - 2) Steel for pipe in accordance with ASTM A 36 or A 53 for sizes 14 inches to 72 inches.
 - b. End Ring and Body:
 - 1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A 536.
 - 2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A 36.
 - c. Follower Ring: Ductile iron in accordance with ASTM A 536 or steel in accordance with ASTM A 36 or A 576.
 - d. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
 - e. Tie Rods: High tensile steel in accordance with ASTM A 193 grade B7.
 - 3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
 - 4. Coating and Lining: Fusion bonded epoxy certified in accordance with ANSI/NSF 61.
- D. Flanged Coupling Adapters:
- 1. Manufacturers: One of the following or equal:

- a. Dresser, Inc., Style 128-W.
 - b. Romac Industries, Inc., Style FCA501 (10 inch and smaller) or Style FC400 (12 inch and larger).
 - c. Smith-Blair, Inc., Series 913.
2. Materials:
- a. Flange and Flanged Body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 psi.
 - b. Follower Ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
 - c. Bolts and Hex Nuts:
 - 1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.

E. Flexible Couplings:

- 1. Manufacturers: One of the following or equal:
 - a. Dresser, Inc., Style 38.
 - b. Smith-Blair, Inc., Series 411.
 - c. Romac Industries, Inc., Style 511 or Style 400.
- 2. Materials:
 - a. Center Sleeve and Follower Flanges: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
 - b. Bolts and Hex Nuts:
 - 1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
- 3. Coating and Lining: Manufacturer's standard fusion bonded epoxy, ANSI/NSF 61 certified.
- 4. Center Sleeve Dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Diameter	Sleeve Length
2-1/2 inch and smaller	Manufacturer's standard
3 inch through 6 inch	7 inch
8 inch through 14 inch	7 inch

Greater than 14 inches	10 inch
------------------------	---------

F. Restrained Flange Coupling Adapters:

1. Manufacturers: One of the following or equal:
 - a. Romac Industries, Inc., Style RFCA.
2. Materials:
 - a. Flange and Flanged Body: Ductile iron in accordance with ASTM A 536.
 - b. Follower Ring: Lug type restraint system.
 - 1) Follower Ring: Ductile iron in accordance with ASTM A 536.
 - 2) Restraining Lugs: Ductile iron in accordance with ASTM A 536.
 - a) Designed to contact the pipe and apply forces evenly.
 - 3) Restraining Bolts: Ductile iron in accordance with ASTM A 536. Bolt heads shall be designed to twist off when the proper torque has been applied.
 - c. Bolts and Hex Nuts:
 - 1) Aboveground: High-strength, low-alloy steel as specified in AWWA C111.
 - 2) Buried and Underwater: Type 316 stainless steel bolts in accordance with ASTM F 593.
3. Flange Design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and Lining: Manufacturer's standard fusion bonded epoxy certified in accordance with ANSI/NSF 61.

G. Double-Grooved Joint High Pressure Couplings:

1. Manufacturers:
 - a. Victaulic Company, Style 808.
 - b. Or approved equal.
2. Materials:
 - a. Housings: Two ductile iron housings in accordance with ASTM A536.
 - b. Gasket: Elastomer in accordance with ASTM D2000.
 - 1) Grade 'N' Nitrile.
 - 2) Grade 'T' EndSeal type.
 - c. Bolts and Nuts: Electroplated steel in accordance with ASTM A449.
 - d. Coating: Manufacturer's standard:
 - 1) Orange enamel.
 - 2) Hot dipped galvanized.
3. Size Range: 6 inch through 12 inch.
4. Operating Pressure:

Size	Pipe Schedule	Max. Joint Working Pressure
6 inch	80	3000 psig

	160	4000 psig
8 inch	80	2500 psig
	160	3500 psig
10 inch	80	2500 psig
	160	2000 psig
12 inch	80	3000 psig
	160	2500 psig

5. For use with Victaulic double grooved fittings, manufactured of carbon steel pipe of the same schedule as the adjoining pipe.

2.03 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Flexible Couplings:

1. Manufacturers: One of the following or equal:
 - a. Dresser, Inc., Style 38.

B. Bolted, Split-Sleeve Couplings:

1. Split-sleeve type pipe coupling with a fully stainless steel double arch cross section. Coupling shall be designed to close around the pipe ends, confining the gaskets beneath the arches of the sleeve. A water-tight, axial seal is created by tightening the bolts to pull the coupling against the outside wall of the pipe.
2. Manufacturers: One of the following or equal:
 - a. "Expansion x Expansion" Configuration:
 - 1) Victaulic, Depend-O-Lok, E x E, Type 2 Coupling.
 - b. "Fixed x Expansion" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x E, Type 2 Coupling.
 - c. "Fixed x Fixed" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x F, Type 2 Coupling.
 - d. "Fixed x Fixed Modified" Configuration:
 - 1) Victaulic, Depend-O-Lok, F x F, Type 2 Modified Restrained Coupling.
3. Materials:
 - a. Couplings: Stainless steel in accordance with ASTM A 240.
 - b. Bolts and Nuts: In accordance with ASTM F 593 and ASTM F 594.
4. Pipe Preparation: Pipe ends shall be smooth for expansion or contraction requirements. Where thrust restraint is required or as indicated on the Drawings, pipe ends shall include restraint rings affixed for pipe end restraint requirements. The coupling manufacturer shall provide restraint rings that shall be shop welded to the pipe in accordance with the manufacturer's requirements. Follow coupling manufacturer's recommendation for size and amount of welding required to attach the restraint rings to the pipe.

C. Grooved Joint Couplings:

1. Manufacturers:

- a. Victaulic Company or equal.
- 2. Materials:
 - a. Housings:
 - 1) Ductile iron in accordance with ASTM A536.
 - 2) Stainless steel in accordance with ASTM A351.
 - b. Gasket: Elastomer in accordance with ASTM D2000.
 - c. Bolts and Nuts:
 - 1) Electroplated steel in accordance with ASTM A449.
 - 2) Stainless steel in accordance with ASTM F593.
- 3. Rigid Type:
 - a. Victaulic Style 89 and W89 (ductile iron housings) or equal.
 - b. Victaulic Style 489 (stainless steel housings) or equal.
- 4. Flexible Type: Victaulic Style 77S or equal.

2.04 GASKETS FOR FLEXIBLE COUPLINGS AND FLANGED COUPLING ADAPTERS

- A. Provide gasket materials for process piping applications as follows:
 - 1. Low Pressure and High Pressure Air, Steam, Hot Water: EPDM.
 - 2. All Other Process Piping Applications: EPDM.

2.05 EXTERIOR COATINGS FOR UNDERGROUND AND SUBMERGED APPLICATIONS

- A. Manufacturers: One of the following or equal:
 - 1. Tapecoat Company, Inc., T.C. Mastic.
 - 2. Kop-Coat Company, Inc., Bitumastic Number 50.
- B. Thickness: Minimum 0.040 inch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. In underground and underwater installations, coat the exterior of coupling with a protective coating after installation.
- B. Joints/flexible connections shall be installed with no angular deflection unless otherwise shown.
- C. Flexible Couplings and Flange Coupling Adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch.
 - 1. Install flexible coupling with pipe gap located in middle of center sleeve.
 - 2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body.

Center Ring Length	Gap Dimension and Tolerance
4 inch through 6 inch	3/8 inch
7 inch	5/8 inch
10 inch and greater	7/8 inch

D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note.

1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 15060.

E. Bolted, Split-Sleeve Couplings:

1. Inspect each coupling to insure that there are no damaged portions of the coupling. Particular attention should be paid to the sealing pad/sealing plate area. Before installation, thoroughly clean each coupling of any foreign substance which may have collected thereon and shall be kept clean at all time thereafter.
2. Wrenches used shall be of a size and type recommended by the manufacturer. Bolts and studs shall be tightened so as to secure a uniform gasket compression between the coupling and the body of the pipe with all bolts or studs tightened approximately the same amount. Final tightening shall be done by hand (no air impact wrenches) and is complete when the coupling is in uniform contact around the circumference of the pipe.
3. No joint shall be misfit any amount that would be detrimental to the strength and water tightness of the finished joint.
4. On the fixed ends of bolted, split-sleeve couplings, the shoulders shall bear on the restraint rings all around with no gap.

F. Grooved Joint Couplings:

1. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions.
2. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
3. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer.
4. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

ELECTRICAL
SPECIFICATIONS
for

SRWA Transfer Pump #3 Improvements

September 20, 2018



The Seal appearing on this
Document was authorized by
Juan-Pablo Cantu, PE, #90105
On 9/20/2018

Juan-Pablo Cantu, P.E.
Square E Engineering
32212 Whipple Rd.
Los Fresnos TX, 78566
Firm # F-12247

**SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS**

ELECTRICAL

PART 1: GENERAL

SCOPE OF WORK:

Furnish and install complete Electrical and SCADA system for the SRWA RO Transfer #3 Addition Improvements Project. Scope of work shall include Furnishing and Installation of a complete Electrical equipment and materials for a fully operational and functional system including all conduit and wiring; conduit fittings; conduit support system; Improvements to Control Panels along with supporting rack systems and all programming; Switchgear and Low Voltage equipment, including the Variable Frequency Drives and all required equipment for a complete and working system as detailed in these plans and specifications for the SRWA RO Facility

1.01 GENERAL

The General Conditions and Requirements, Special Provisions, if applicable are hereby made a part of this section.

- A. The Electrical Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the Owner's office and shall be examined by all bidders. Failure to examine all documents shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.
- B. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents.
- C. The Contractor is responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly. Failure to examine all site conditions shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.
- D. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

E. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should

SECTION 16000 GENERAL ELECTRICAL SPECIFICATIONS

work be required which is not set forth in either document, but which work is

nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

H. The use of the word "*furnish*" or "*install*" or "*provide*", shall be taken to mean that the item or facility is to be both furnished and installed under this section unless specifically stated to the contrary that the item or facility is to be furnished under another section and installed under this section; furnished under this section and installed under another section; or furnished and installed under another section.

I. The use of the term "as or where Indicated"; "as or where shown"; "as or where specified"; or "as or where scheduled" shall be taken to mean that the reference is made to the contract documents either under the drawings and/or the specifications.

1.02 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. It is the responsibility of the contractor to investigate and identify all required permits, licenses and inspections required and investigate and identify any AHJ. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

D. Determine the exact requirements for **ALL** utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform **ALL** work as required by those utilities.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

1.03 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. All materials and equipment shall be of the highest quality in order to provide the most reliable end product possible. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)

B. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturer's Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code
6. National Fire Protection Association

C. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

E. All products shall bear UL labels where standards have been set for listing.

1.04 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings shall be taken to mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

C. Submit for review in sextuplet within fifteen (15) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and submittals are not received in fifty (15) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne

**SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS**

by the contractor.

D. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.

E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's representative and such procedures will not be cause for delay. After final review, supply up to six (3) copies, if requested.

G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each Submittal and/or shop drawing.

H. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.

I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent.

J. Materials to be submitted as required are as follows:

- | | |
|------------------------------|---------------------------------------|
| 1. Variable Frequency Drives | 6. Control Panel Enclosures |
| 2. Meters | 7. Electrical Equipment and Materials |
| 3. Wire & Wiring Devices | 8. Software and Programming materials |
| 4. Conduit and Fittings | 9. |
| 5. J-Boxes | 10. |

K. Each submittal shall be accompanied with a written statement certifying that the submitted equipment and/or material meet the plans and specifications.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

1.05 ACCEPTANCE AND SUBSTITUTIONS

- A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.
- B. Substitutions after award of contract shall be made only within sixty (15) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.
- C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.
- D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, the contractor shall assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.
- E. Energy Efficiency of each item of power consuming equipment shall be considered one of the standards for evaluation.

1.06 EXCAVATION AND BACKFILLING (as required)

- A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.
- B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.
- C. All backfilling shall be made with Concrete Backfill.
- D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

G. Any construction involving the opening of trenches and or Sidewalks and Concrete Drives is to be done in an efficient manner so as to reduce the impact of to surrounding areas. Trenches are shall not be left open during periods of rain so as to reduce the impact of the weather to surrounding areas/structures.

1.07 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

G. No cutting of structural elements shall be done without permission of the Engineer.

1.08 WATERPROOFING

A. Interiors of raceways that are likely to have water ingress such as runs to and from J-Boxes, Control Boxes shall have water-stops/sealing hubs etc. installed to

SECTION 16000 GENERAL ELECTRICAL SPECIFICATIONS

prevent water from entering into installations.

1.09 CONSTRUCTION REQUIREMENTS

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the engineer in advance of construction. Confirmed locations shall be made for the following:

1. Poles
2. Receptacles
3. Rough-ins and connections for equipment furnished under other sections
4. Lighting Fixtures
5. Outlets
6. J-Boxes, Control Panels, and, Switchgear, Electrical Panels, Control Panels etc.

B. All work shall be done in the best and most workmanlike manner by qualified careful electricians who are skilled in their trade. The standards of work required throughout shall be of the first class only and electricians whose work is unsatisfactory to the Engineer shall be instantly dismissed from the work upon written notice from the Engineer at no additional cost to the Owner. All work must meet the approval of the Engineer.

D. Unless shown in detail, the drawings are diagrammatic and do not give exact details as to the elevations and routing of conduits, nor do they show all offsets and fittings. Nevertheless, the installation must be made to fit and conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are shown, confirm locations and routing prior to installation with Engineer.

E. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole-punch. Cutting openings with a torch or other device that produces a jagged edge, rough cut will not be acceptable.

F. Raceway entry into equipment shall be carefully planned. Cutting of enclosure framework to accommodate poorly planned raceway placement will not be acceptable. No hole-punch penetrations shall be made on top of any equipment, panel, or Junction box. All hole-punch penetrations shall be properly sealed so as to prevent moisture and gasses from entering the equipment, panel, or Junction Box etc.

G. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be acceptable.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

H. Equipment, inclusive of supporting devices, shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid tight fitting manner.

1.10 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

E. Interiors of Switchgear, Motor Control Centers, Control Panels, shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200 watt Lamp located the bottom of each section, or panel. Energizing integral condensation heaters shall be acceptable in place of lamps.

1.11 COOPERATION WITH WORK UNDER OTHER SECTIONS

A. Cooperate with all other trades so as to facilitate the general progress of the work. Allow other trades every reasonable opportunity for then installation of their work and the storage of their materials.

B. The work under this section shall follow the general construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before any concrete is placed or masonry is installed.

C. Work with other trades in determining exact locations of outlets, conduits, fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime as required to accomplish these requirements if directed to do so.

1.12 CLEAN-UP

SECTION 16000 GENERAL ELECTRICAL SPECIFICATIONS

- A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.
- B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.
- C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.13 TESTING AND ENGINEERING STUDIES

- A. All cables shall have an insulation test performed using a 1000 Volt Megger tester. Testing shall include the entire length of cable from the source terminal to the load terminal. Testing shall be performed prior to final landing of power cables to equipment. Reports are to be made during the time of the testing and submitted to the Engineer for review. Reports must include time and date, weather conditions, printed names and signatures of tester and at least one witness. Testing must be performed in the presence of the Engineer/Owner Representative. Insulation values of each cable shall be equivalent to or greater than 500,000 ohms. In the event a cable's test value is not equivalent or greater than 500,000 ohms, that cable shall be removed and replaced. Upon reinstallation, **ALL** cables are to be retested. Retesting must result in the same resistance value equal to or greater than 500,000 ohms. Retested and/or replaced cables are required to achieve the proper resistance rating.
- B. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner.

1.14 RECORD DRAWINGS

- A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.
- B. Show conduit routing and wiring runs as constructed and identify each.
- C. Record all deviations from the Contract Documents.
- D. Submit set of marked-up drawings for review.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

1.16 OPERATIONS AND MAINTENANCE MANUALS

- A. Prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.
- B. Submit six (3) copies for review.

PART 2 PRODUCTS

2.01 RACEWAYS

- A. Above ground rigid metallic conduit shall be schedule 40 Aluminum conduit, Rigid Conduit, or PVC coated plastibond conduit with like fittings as indicated on plans sheets. Conduit couplings shall be threaded Aluminum, Rigid, or PVC coated plastibond as indicated on plansheets. Such conduit shall be Republic, Triangle, Wheatland, or equivalent. Please provide full submittal for review and acceptance by Engineer. Conduits in wet areas shall be PVC Coated Conduits with PVC Coated couplings and condulets.
- B. Rigid non-metallic conduit shall be Schedule 40 PVC plastic type DB. Couplings shall be PVC solvent weld type. Such conduit shall be Carlon, or equivalent.
- C. 90 degree transitions from underground to above shall be PVC Coated Rigid Conduit. Couplings shall be PVC Coated Plastibond Couplings with PVC solvent weld type Adapter in ductbank. Above Ground use PVC Coated Couplings for transition to Aluminum Conduit above ground. The transition shall be 12" minimum above ground with PVC Coated conduit transition and nipples. The Contractor shall use long sweep 90 degree bends as required. All above ground nipples shall be cut uniformly including threading to provide a uniform neat and workman like appearance.

2.02 CONDUIT FITTINGS

- A. Rigid metallic conduit locknuts shall be galvanized steel, Aluminum, or PVC coated plastibond as indicated on the plan sheets, in sizes under 2" and galvanized malleable iron on sizes 2 ½" and larger. Sealing locknuts shall also have an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4. These lock nuts shall have a integral grounding terminal for proper grounding. These fittings and shall be MYERS "SCRU-TITE", or equal.
- B. Chase nipples, reducers, enlargers, "Ericksons", capped els, short els, long els, split couplings and fittings shall be HDG malleable iron threaded type for use with rigid metallic conduit. All such fittings shall be PVC coated where as required.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

C. Rigid metallic conduit locknuts shall be galvanized steel in sizes under 2" and galvanized malleable iron on sizes 2 ½" and larger. Sealing locknuts shall have in addition to that specified above, an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4.

D. Rigid metallic conduit insulating bushings shall be molded canvas bakelite type suitable for operation in 100°C rise over 40°C ambient. Polypropylene bushings will not be acceptable.

E. Rigid Metallic Conduit Grounding type bushings shall be Hot Dipped Galvanized steel with threaded steel body insulated throat, and ground lug. Insulated throat shall meet specifications under article D above.

F. Rigid metallic conduit expansion/deflection fittings shall be water-tight with flexible plastic sleeve that allows ¾" movements in all directions. Hubs shall be threaded, hot dipped galvanized (HDG) malleable iron. Clamping bands shall be stainless steel. There shall be on equipment ground bonding jumper, Expansion deflection fittings shall be Crouse-Hinds, OZ, or equivalent.

G. Rigid metallic conduit hubs shall be liquid-tight type with threaded HDG malleable iron female body, with sealing ring on conduit side and threaded male tapered steel body with hardened steel locknut on box side. Plastic jacketed hubs shall have 40 mils PVC coating. Such fittings shall be OCAL "Blue" or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote "Supreme" shall be acceptable.

H. Cadmium and electro-galvanized plated devices and hardware shall not be acceptable.

2.03 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.

B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal.

C. Rigid metallic conduit bodies shall be HDG malleable iron type with threaded hubs, gasketed metal covers, with stainless steel screws. Plastic jacketed type shall have 40 mils minimum coating of PVC. Such conduit shall be OCAL "Blue" or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote "Supreme" shall be acceptable.

**SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS**

D. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.

E. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws.

F. Rigid metallic conduit boxes shall be HDG cast iron, with threaded integrally-cast hubs, cast metal cover, and stainless steel cover screws. Such boxes shall be Crouse Hinds, Appelton, or equivalent. Plastic jacketed type shall have 40 mils minimum coating of PVC.

2.04 WIRE AND CABLE

A. Contractor shall refer to Section 16123. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.

B. All 480V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75°C. Furnish okonite "Okolon", Rockbestos "Firewall", or equal.

C. All 120/240V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75°C. Furnish okonite "Okolon", General Cable, South Wire, Encore, or Engineer approved equal.

D. Factory pigmented insulation color for sizes #6 and smaller for power wiring shall be as follows:

150V to Ground, or less:

<u>Phase</u>	<u>Color</u>
A	Black
B	Red
C	Blue
Grounding Conductor	Green
Grounded Conductor	White
Greater than 150V to ground	

**SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS**

<u>Phase</u>	<u>Color</u>
A	Brown
B	Orange
C	Yellow
Grounding Conductor	Green
Grounded Conductor	Gray

E. Bare conductors for grounding purposes shall be hard-drawn stranded copper.

2.05 CONNECTORS

A. Mechanical connectors shall be copper alloy bolted pressure type with bronze hardware.

B. Insulated spring-wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 105° C continuous. Furnished 3M "Hyflex", T&B "PT" or equal.

C. Insulated set-screw connectors shall consist of copper body with flame-retardant 600V plastic insulated shield. Furnished Ideal, T&B, or equal.

D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrel and tin-plated copper ring-tongue style connector. Furnish T&B "Sta-kon", 3M "Scotchlok", or equal.

E. Terminal strips shall be channel-mounted type with tin-plated solderless box lugs contained with barriered nylon-insulated separable barriers. Such devices shall be Square D, Cutler Hammer, Allen Bradley, or equivalent.

F. Terminal connectors for flat head terminal screws shall be locking spade type with vinyl insulated compression indent shaft, T&B, Ideal, Amp, or equivalent.

2.06 INSULATING PRODUCTS

A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, F.E., 3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, "slipknot Grey", 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

moisture-proof void filling tape shall be "plysafe", 3M Scotch 23, or equal.

D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be "Plysil #3445", 3M Scotch 70, or equal.

E. Insulation putty filler-tape shall be Plymouth #2074, 3M, or equal. Putty to be used as necessary to keep moisture and gasses from entering raceways.

2.07 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.

B. Numbered marking labels shall be colored vinyl markers, T&B, Brady, or equal.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.

D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking "BURIED CONDUIT", or similar language, along its length.

E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with white engraving. Attachment means shall be self-tapping stainless steel screws.

2.08 GROUNDING DEVICES

A. Exothermally welded joints shall be made with Enrico "cadweld", Burndy "Thermweld", or equal kits.

B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.

C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.

2.09 SUPPORTING DEVICES

A. Contractor shall refer to Section 16070 Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be good quality Aluminum; 1-5/8" wide x 3-1/4" deep unistrut. Clamp nuts and mounting

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

hardware for use with slotted channels shall be grade 316 stainless steel.

C. Conduit straps for use with slotted channels shall be stainless steel with stainless steel hardware. HDG unistrut and straps shall be acceptable for this project. Please provide full submittal for Engineer review and acceptance.

D. Concrete and Masonry Anchors shall be stainless steel type. Furnish Hilti, or equal.

E. Poles for supporting outdoor control panels shall be Hot Dipped Galvanized, with footings encased in concrete. Tops of poles shall be covered with a Hot Dipped Galvanized conduit cap.

H. "U" bolts shall be stainless steel with Stainless Steel hex-head bolts.

I. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.10 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Zinc spray for coating electrogalvanized steel products shall be Research

SECTION 16000 GENERAL ELECTRICAL SPECIFICATIONS

Laboratory type "LPS", Mobil "Zinc-spray", or equal.

H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

PART 3: INSTALLATION

3.01 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, will not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of structures. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.

E. Unless otherwise indicated, conduit runs installed below-grade in earth shall be schedule 40 PVC electrical conduit. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that tops of conduits are at least Thirty-Six (36") inches below finished grade. Support runs on plastic spacers and backfill to three (3") inches above and all around including topmost conduits with 3000 PSI Red Concrete. Complete backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped.

F. Below-grade to above-grade upturns in non-metallic runs shall be made with Schedule PVC Coated rigid conduit as in **PART 2 PRODUCTS 2.01 RACEWAYS**

C.

G. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.

H. All conduit runs shall be watertight over their lengths of run except where drain

SECTION 16000 GENERAL ELECTRICAL SPECIFICATIONS

fittings are indicated. In which cases, install specified breather-drain fittings.

I. Empty conduits shall have pull-tape installed. Identify each terminus as to location of other end. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Cap exposed ends of empty conduit with plastic caps.

J. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

K. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

L. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, fagged edges, and torn metal.

M. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.

N. Surface mounted conduit and all fittings shall be schedule 40 Aluminum conduit and shall conform to Section, 2.01 RACEWAYS; A. Mounting hardware shall be Aluminum Deep Channel Unistrut with stainless steel hardware including nuts, bolts, anchor bolts and pipe clamps.

3.02 CONDUIT BODIES AND BOXES

A. Contractor shall refer to Section 16134. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction. PVC coated fittings shall be used as required.

B. Covers for conduit bodies installed shall be gasketed cast metal type.

C. All conduit boxes installed shall be cast metal type Aluminum as required or indicated. Covers for all such boxes shall be gasketed stainless steel to match box construction.

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

3.03 RACEWAY SUPPORT

A. Contractor shall refer to Section 16070. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Below-grade conduits shall be supported with plastic saddles.

3.04 WIRING

A. Branch circuits may be spliced for receptacle, lighting and small appliances load inside appropriate junction boxes.

B. Except as otherwise specified, taps and splices with #10 AWG and smaller shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be further insulated with an envelope of stretched piece of EPR tape around each wire to fill the interstices between the wires. Then, apply one-half lapped layer of electrical tape over all.

C. Taps, splices, and connection in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

D. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

E. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

F. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

G. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

H. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety

SECTION 16000
GENERAL ELECTRICAL SPECIFICATIONS

switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

I. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

J. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

3.05 WIRING DEVICES

A. Contractor shall refer to Section 16140. Install wiring devices where indicated. Wiring devices shall be type as indicated.

B. Each wiring device shall be set with axis plumb and installed with yoke screw so as to adequately support device yokes to the box.

C. Device boxes shall be cast metal condulets or equal.

D. Use ganged boxes for ganged devices.

E. Each device box shall be equipped with specified cast metal cover.

3.06 GROUNDING

(Refer to Section 16060)

SECTION 16030
ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

PART 1 GENERAL

1.01 ENGINEERING STUDIES

A. The coordination report shall include all portions of the electrical distribution system from the normal power source or sources down to and including each low voltage secondary main breaker. All plant electrical facilities, both new and future, shall be included in the report as indicated on the Overall One Line Diagrams and other pertinent Electrical drawings. Normal system connections and those, which result in maximum and minimum fault conditions, shall be adequately covered in the report. Additional information if necessary may be obtained from the local Utility.

B. The coordination report shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The firm performing the work shall be currently involved in high- and low-voltage power system evaluation. The work shall be performed, stamped and signed by a professional engineer currently licensed in the State of Texas. Credentials of the individual(s) performing the work and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of ten (10) years' experience in power system analysis is required for the individual in charge of the project.

D. The firm performing the work shall demonstrate capability and experience to provide assistance during start up as required.

1.02 DATA COLLECTION

A. Any data which is necessary for completion of the studies shall be obtained by the Contractor

B. The Contractor shall expedite completion of the work and submission of the report as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

PART2 Products

2.01 Short-Circuit and Coordination Report

A The short-circuit and coordination effort shall be performed using SKM PowerTools , ETAP, or Engineer approved computer software. Contractors shall use latest

SECTION 16030 ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

version of any software proposed. Methods shall be in accordance with the latest applicable IEEE and ANSI standards.

B. In the short-circuit report, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each switchgear bus, transformer primary and secondary terminals, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA and symmetrical and asymmetrical fault currents.

C. In the protective device coordination report, provide time-current curves (TCC) graphically indicating the coordination proposed for the system, centered on conventional, log-log forms 11 inch x 17 inch minimum size. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Use manufacturers application software for microprocessor based relays. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings for all devices in a Microsoft Excel spreadsheet.

D. Include on the TCC curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics of other system load protective devices. In addition, include all devices down to each low voltage secondary main breaker. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

E. Select each primary protective device required for a wye-wye connected transformer so that it's characteristic or operating band is within the transformer characteristics; including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from downstream device curves by at least a 0.4-second time margin over relays and 0.2 seconds over fuses.

SECTION 16030
ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

F. Include complete fault calculations as specified herein based on design documents and field survey data.

G. Submit qualifications of engineer(s) who will perform the work for approval prior to commencement of work. Provide reports in conjunction with equipment submittals to verify equipment ratings required. Submit a preliminary report to the Engineer for review and approval prior to delivery of final report. Make all additions or changes as required by the reviewer.

H. Notify the Engineer in writing of any circuit protective devices found to be not properly rated for fault conditions.

I. As part of this report the Contractors shall provide a Harmonic analysis of the entire electrical system is required as a part of this project. This report is intended to show the effects of the VFD's and other Harmonic generating equipment on the electrical system and to verify system conformance with IEEE Std. 519. The point of Common Coupling shall be taken at the interconnection between the Pad Mount transformer and the Main Incoming breaker. The full load amps for the system shall include all motors running (using NEC tables for motor ampacity) with an additional 100A assumed as the MCC load. The testing company should contact the local utility for any additional information required regarding available fault current of the utility system/transformer.

- 1.) Short-Circuit Analysis shall consist, but not be limited to the following
 - a. Calculation of the maximum RMS symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.
 - b. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
 - c. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
 - d. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 - e. Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
 - f. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit

SECTION 16030
ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

- analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- g. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
 - h. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.
- 2.) Protective Device Time-Current Coordination Analysis
- a. The time-current coordination analysis shall be performed with the aid of computer software intended for this purpose, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
 - b. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection considered more important than service continuity.
 - c. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 - d. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
 - e. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
 - f. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
 - h. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
 - i. Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.
 - j. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system

SECTION 16030 ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

information in a timely manner to allow the time-current analysis to be completed prior to final installation.

3.) Load Flow and Voltage Drop Analysis

- a. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and include calculations of power flow in all three-phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.
- b. The analysis shall provide the calculated maximum values of kVA, kW, kVAR, power factor, and amperes for each power circuit.
- c. The calculated power losses in each branch and total system losses shall be provided.
- d. A computer printout listing all cables, transformers, loads, and other circuit data shall be included.
- e. Provide tabular bus-to-bus computer printouts listing the calculated values.
- f. The analysis shall include a computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.
- g. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.
Significant deficiencies in loading or voltage levels shall be called to attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

2.02 FINAL REPORT

- A. The results of the power system study shall be summarized in a final report. Four (4) bound copies of the final report shall be submitted.
- B. The report shall include the following sections:
 1. Descriptions, purpose, basis, and scope of the analysis.
 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 5. SKM electronic files including project, library and report files.
 6. Excel electronic files on tabulated protective device settings.

SECTION 16030
ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

PART 3 EXECUTION

3.01 FIELD SETTINGS

- A. Field setting and calibration of protective devices shall be performed in accordance with Section 16600.
- B. Necessary adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination report shall be carried out by the Contractor at no additional cost to the City.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Grounding electrodes.
 - 2. Grounding electrode conductors.
 - 3. Equipment grounding conductors.
 - 4. Main bonding jumper.
 - 5. Ground connections.
 - 6. General requirements for grounding.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – General Electrical Specifications

1.02 REFERENCES

- A. As specified in Section 16000.

- B. ASTM International (ASTM):
 - 1. B 3 – Standard Specification for Soft or Annealed Copper Wire.
 - 2. B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

- D. Underwriters Laboratories, Inc. (UL):
 - 1. 467 – Ground and Bonding Equipment.

1.03 DEFINITIONS

- A. As specified in Section 16000.

1.04 SYSTEM DESCRIPTION

- A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.
- B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
 - 1. Grounding electrodes.
 - 2. Bonding jumpers.
 - 3. Ground connections.
- C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.
- D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 16950, shall be:
 - 1. 5 ohms or less for industrial systems.
 - 2. 1 ohm or less for electrical buildings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications
- B. Product data:
 - 1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000.
- B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000.

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000.

1.12 SYSTEM START-UP

- A. As specified in Section 16000.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Compression steel connectors: One of the following or equal:
 - 1. FCI Burndy.
 - 2. Thomas & Betts.

- B. Exothermic connectors: One of the following or equal:
 - 1. Erico.
 - 2. Harger.
 - 3. Burndy Weld.

- C. Ground rods: One of the following or equal:
 - 1. Erico.
 - 2. Harger.
 - 3. Conex.

- D. Ground cable: One of the following or equal:
 - 1. Nehring.
 - 2. Harger.
 - 3. Southwire.

- E. Precast ground well boxes: One of the following or equal:
 - 1. Brooks Products, 3-RT Valve Box.
 - 2. Christy Concrete Products, G12 Valve Box.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Ground rod:
 - 1. Minimum: 3/4-inch diameter, 10 feet long.
 - 2. Uniform 10 mil covering of electrolytic copper metallurgically bonded to a rigid steel core:
 - a. The copper-to-steel bond shall be corrosion resistant.
 - 3. In accordance with UL 467.
 - 4. Sectional type joined by threaded copper alloy couplings.
 - 5. Fit the top of the rod with a threaded coupling and steel-driving stud.
 - 6. Minimum of three rods spaced the length of the rod as indicated in the NEC.

- B. Ground cable:
 - 1. Requirements:
 - a. Soft drawn (annealed).
 - b. Concentric lay, coarse stranded in accordance with ASTM B 8.
 - c. Bare copper in accordance with ASTM B 3.
 - 2. Size is as indicated on the Drawings, but not less than required by the NEC.

- C. Compression connectors:
 - 1. Manufactured of high copper alloy specifically for the particular grounding application.
 - 2. Suitable for direct burial in earth and concrete.
 - 3. Identifying compression die number inscription to be impressed on compression fitting.

- D. Exothermic welds:
 - 1. Current carrying capacity equal to that of the conductor.
 - 2. Permanent molecular bond that cannot loosen or corrode over time.
 - 3. Will not deteriorate with age.

- E. Equipment grounding conductors:
 - 1. Conductors shall be the same type and insulation as the load circuit conductors:
 - a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
 - 2. Minimum size in accordance with the NEC.

- F. Grounding electrode conductors:
 - 1. Minimum size in accordance with the NEC.

- G. Main bonding jumpers and bonding jumpers:
 - 1. Minimum size in accordance with the NEC.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Precast ground well boxes:
 - 1. Minimum 10 inch interior diameter.
 - 2. Traffic-rated cast iron cover.
 - 3. Permanent "GROUND" marking on cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16050.
- B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
 - 1. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
 - 2. Provide a separate grounding conductor in each individual raceway for parallel feeders.
- C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
 - 1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.
- D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
 - 1. Individually bond these raceways to the ground bus in the equipment.
- E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.
- F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.
- G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.
- H. Duct bank ground system:
 - 1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as specified in the Specifications.
 - 2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.
- I. Grounding at service (600 V or Less):
 - 1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.
- J. Ground connections:
 - 1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors or exothermic welds as required, UL listed, and labeled for the application.
 - 2. Make ground connections in accordance with the manufacturer's instructions.

3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings or specified in the Specifications.
- K. Grounding electrode system:
1. Ground ring:
 - a. Provide all trenching and materials necessary to install the ground ring around process facility and structures or indicated on the Drawings. Ground ring shall be required for all structures.
 - b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size per NEC.
 - c. Minimum burial depth 36 inches.
 - d. Re-compact disturbed soils to original density in 6 inch lifts.
 2. Ground rods:
 - a. Locations at corners of structures, structural members or as indicated.
 - b. Length of rods forming an individual ground array shall be equal in length.
 - c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
 - d. Pre-crimp all ground rods, as recommended by the manufacturer, before crimping connector to ground rod.
 3. Metal underground water pipe:
 - a. Bond metal underground domestic water pipe to grounding electrode system.
 4. Metal frame of building or structure:
 - a. Bond metal frame of building or structure to grounding electrode system.
 5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.
 6. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.
- L. Shield grounding:
1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:
 - a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.
 2. Terminate the shield drain wire on a dedicated terminal block.
 3. Use manufacturer's terminal block jumpers to interconnect ground terminals.
 4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.
- M. Telephone panel ground:
1. Install individual ground rod or ground system at telephone panels:
 - a. Install a dedicated grounding electrode conductor from the telephone panel to the grounding electrode system.
 - b. Do not connect any other grounds to the telephone panel grounding electrode conductor.
 2. Install ground rod or ground system in accordance with telephone company requirements.
- N. Where indicated on the Drawings, install ground rods in precast ground wells.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16000.
- B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

3.08 ADJUSTING

- A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
 - 1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 16000.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16070
HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Mounting and supporting electrical equipment and components.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – General Electrical Specifications

1.02 REFERENCES

- A. As specified in Section 16000.

- B. ASTM International (ASTM):
 - 1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. A 240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 DEFINITIONS

- A. As specified in Section 16000.

1.04 SYSTEM DESCRIPTION

- A. Design requirements:
 - 1. Conform to the requirements of the Building Code as required.

2. Demonstrate the following using generally accepted engineering methods:
 - a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
 - b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
 3. Design loading and anchoring requirements:
 - a. As indicated in the Building Code unless otherwise specified.
 - b. Seismic loading requirements:
 - 1) Freestanding or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 16000.
 - c. Wind loading requirements:
 - 1) All exterior freestanding equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 16000.
 - d. Minimum safety factor against overturning: 1.5.
 - e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.
- B. Performance requirements:
1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Product data:
1. Supports:
 - a. Materials.
 - b. Geometry.
 - c. Manufacturer.
 2. Hardware:
 - a. Materials.
 - b. Manufacturer.
- C. Shop drawings:
1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
 2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
 - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.
 - b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.

3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

D. Installation instructions:

1. Furnish anchorage instructions and requirements based on the wind conditions of the Site:
 - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000.

1.12 SYSTEM STARTUP

- A. As specified in Section 16000.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
1. Thomas & Betts.
 2. Power-Strut.
 3. Unistrut.
 4. Cooper B-Line.
 5. Robroy.
 6. Aickinstrut.
 7. Champion.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Use materials appropriate for the area as specified in Section 16000.
- B. Stainless steel:
 - 1. Supports:
 - a. In accordance with ASTM A 240.
 - b. ANSI Type 316 material.
 - 2. Hardware:
 - a. ANSI Type 316 material.
- C. PVC coated galvanized steel:
 - 1. Supports:
 - a. Hot dip galvanized steel as specified in this Section.
 - b. PVC coating thickness of 10 to 20 mils.
 - 2. Hardware:
 - a. ANSI Type 316 material.
- D. Fiberglass:
 - 1. Supports:
 - a. Vinyl ester.
 - 2. Hardware:
 - a. Polypropylene.
 - b. Thermal plastic elastomer.
 - c. Fiberglass reinforced plastic.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Anchor bolts:
 - 1. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Paint and finish all supporting structures as specified in Section 16000 and other pertinent sections of the Plans and Specifications.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
 - 1. Provide the necessary sway bracing to keep trapeze type structures from swaying.
- C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
 - 1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.
- D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
 - 1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
 - 2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
 - 3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.
 - 4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
 - a. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.
- E. Corrosion protection:
 - 1. Isolate dissimilar metals, except where required for electrical continuity.
 - a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.
- F. Raceway:
 - 1. Furnish all conduit racks and trapeze structures needed to support the raceway from the structure.
 - a. Group conduits and position on racks to minimize crossovers.
 - b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.
- G. Anchoring methods:
 - 1. Solid concrete: Anchor bolts, anchor rods, or post-installed anchors as specified in Section 05190.
 - 2. Metal surfaces: Machine screws or bolts.
 - 3. Hollow masonry units: Post-installed anchors as specified in Section 05190.
- H. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

- I. Re-coat all scratches, cuts, and drilled holes in galvanized surfaces with CRC "Zinc-It" or similar product.
- J. Re-coat all drilled holes and cut surfaces on PVC-coated materials.
- K. Seal all drilled holes and cut surfaces on fiberglass materials.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Identifying electrical, instrumentation, and process equipment and components.
 - 2. Material, manufacturing, and installation requirements for identification devices.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – General Electrical Specifications
 - c. Section 16130 – Conduits.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

- A. As specified in Section 16000.

1.04 SYSTEM DESCRIPTION

- A. Nameplates:
 - 1. Provide a nameplate for each piece of mechanical equipment, process equipment, valve, pump, mixer, feeder, fan, air-handling unit, motor, switch, receptacle, controller, instrument transducer, instrument power supply, solenoid, motor control center, starter, panelboard, switchboard, individually mounted or plug-in type circuit protector or motor controller, disconnect switch, bus duct tap switch, time switch, relay and for any other control device or major item of electrical equipment, either located in the field or within panels.
 - 2. Provide all nameplates of identical style, color, and material throughout the facility.

3. Device nameplates information:
 - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
 - b. Device tag and loop number ID (#) (e.g. EDV-#).
 - c. Circuit ID (e.g. LPA-11).
 - d. Area served (e.g. Lighting Chemical Building).
- B. Wire numbers:
 1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
 - a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
 - b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
 - c. Internal panel wires on a common terminal shall have the same wire number.
 - d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
 - 1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in Section 16130.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Product data:
 1. Nameplates:
 - a. Color.
 - b. Size:
 - 1) Outside dimensions.
 - 2) Lettering.
 - c. Material.
 - d. Mounting means.
 2. Nameplate schedule:
 - a. Show exact wording for each nameplate.
 - b. Include nameplate and letter sizes.
 3. Wire numbers:
 - a. Manufacturer's catalog data for wire labels and label printer.
- C. Record documents:
 1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.08 PROJECT SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16000.

1.12 SYSTEM STARTUP

A. As specified in Section 16000.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nameplates and signs:
 - 1. One of the following or equal:
 - a. Brady.
 - b. Seton.

- B. Conductor and cable markers:
 - 1. Heat-shrinkable tubing:
 - a. One of the following or equal:
 - 1) Raychem.
 - 2) Brady.
 - 3) Thomas & Betts.
 - 4) Kroy.

- C. Conduit and raceway markers:
 - 1. One of the following or equal:
 - a. Almetek: Mini Tags.
 - b. Lapp Group: Maxi System.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Nameplates:
 - 1. Fabricated from white-center and Black face laminated plastic engraving stock:
 - a. 3/32 inch thick material.
 - b. Two-ply.
 - c. With chamfered edges.
 - d. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
 - 1) No characters smaller than 1/8 inch in height.
- B. Signs:
 - 1. Automatic equipment and high voltage signs:
 - a. Suitable for exterior use.
 - b. In accordance with OSHA regulations.
- C. Conductor and cable markers:
 - 1. Machine printed black characters on white tubing.
 - 2. Ten point type or larger.
- D. Conduit and raceway markers:
 - 1. Non-metallic:
 - a. UV resistant holder and letters.
 - b. Black letters on yellow background.
 - c. Minimum letter height: 1/2 inch.
 - d. Adhesive labels are not acceptable.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Nameplates:
 - 1. Provide all nameplates for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):
 - a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000.
- B. Nameplates:
 - 1. Attach nameplates to equipment with rivets, bolts, or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
 - 2. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based cement to attach nameplates.
 - 3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
 - a. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the Engineer.
- C. Conductor and cable markers:
 - 1. Apply all conductor and cable markers before termination.
 - 2. Heat-shrinkable tubing:
 - a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
 - b. Tubing shall be tight on the wire after it has been heated.
 - c. Characters shall face the open panel and shall read from left to right or top to bottom.
 - d. Marker shall start within 1/32 inch of the end of the stripped insulation point.
- D. Conduit markers:
 - 1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
 - a. Conduit markings shall match the conduit schedule; as indicated on the Drawings.
 - 2. Mark conduits at the following locations:
 - a. Each end of conduits that are greater than 10 feet in length.
 - b. Where the conduit penetrates a wall or structure.
 - c. Where the conduit emerges from the ground, slab, etc.
 - d. The middle of conduits that are 10 feet or less in length.
 - 3. Mark conduits after the conduits have been fully painted.
 - 4. Position conduit markers so that they are easily read from the floor.
 - 5. Attach non-metallic conduit markers with nylon cable ties:
 - a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
 - 6. Mark conduits before construction review by Engineer for punch list purposes.
 - 7. Label intrinsically safe conduits in accordance with the requirements of the NEC.

- E. Medium voltage raceway labels:
 - 1. Apply at 50 foot intervals stating the voltage level contained within the raceway.

- F. Signs and labeling:
 - 1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
 - a. Fasten warning signs with round head stainless steel screws or bolts.
 - b. Locate and mount in a manner to be clearly legible to operations personnel.
 - 2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
 - 3. Furnish and install warning signs on equipment that has more than one source of power.
 - a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
 - 4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
 - a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. Replace any nameplates, signs, conductor markers, cable markers, or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16123

600 VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. 600 volt class wire and cable.
 - 2. Instrumentation class wire and cable.
 - 3. Network cable.
 - 4. Fire alarm wire and cable.
 - 5. Telephone wire and cable.
 - 6. 600 volt class tray cable.
 - 7. 600 volt class armored cable.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – Common Work Results for Electrical.
 - c. Section 16060 – Grounding and Bonding.
 - d. Section 16075 – Electrical Identification.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. ASTM International (ASTM):
 - 1. B 3 – Standard Specification for Soft or Annealed Copper Wire.
 - 2. B 8 – Standard Specification for Concentric-Lay–Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

- C. CSA International (CSA).

- D. Insulated Cable Engineers Association (ICEA):
 - 1. NEMA WC 70/ICEA S-95-658-1999 – Standard for Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 - 2. NEMA WC 57/ICEA S-73-532 – Standard for Control, Thermocouple Extension, and Instrumentation Cables.

- E. National Electrical Code (NEC).

- F. National Electrical Manufacturers Association (NEMA):
 - 1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).
- G. National Fire Protection Association (NFPA):
 - 1. 72 – National Fire Alarm and Signaling Code.
 - 2. 101 – Life Safety Code.
- H. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
 - 1. 568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
- I. Underwriter's Laboratories Inc., (UL):
 - 1. 44 – Thermoset-Insulated Wires and Cables.
 - 2. 1424 – Standard for Cables for Power-Limited Fire-Alarm Circuits.
 - 3. 1569 – Standard for Metal-Clad Cables.
 - 4. 2196 – Standard for Tests for Fire Resistive Cables.
 - 5. 2225 – Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

- A. As specified in Section 16000.
- B. Definitions of terms and other electrical considerations as set forth in the:
 - 1. ASTM.
 - 2. ICEA.
- C. NEMA:
 - 1. Type 4 enclosure in accordance with NEMA 250.
 - 2. Type 4X enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

- A. Furnish and install the complete wire and cable system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Product data:
 - 1. Manufacturer of wire and cable.
 - 2. Insulation:
 - a. Type.
 - b. Voltage class.
 - 3. American wire gauge (AWG) size.
 - 4. Conductor material.
 - 5. Pulling compounds.
- C. Shop drawings:
 - 1. Show splice locations.

- D. Test reports:
 - 1. Submit test reports for meg-ohm tests.
- E. Calculations:
 - 1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
 - a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
 - b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. All wires and cables shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal (XHHW-2):
 - 1. 600 volt class wire and cable:
 - a. General Cable.

- b. Okonite Company.
 - c. Southwire Company.
 - d. Encore.
- 2. Instrumentation class wire and cable:
 - a. Alpha Wire Company.
 - b. Belden CDT.
 - c. General Cable BICC Brand.
 - d. Okonite Company.
 - e. Rockbestos Surprenant Cable Corporation.
- 3. Network cables:
 - a. Belden CDT.
 - b. Panduit.
 - c. TE Connectivity.
- 4. Fire alarm wire and cable:
 - a. West Penn Wire.
 - b. Olympic Wire and Cable.
 - c. Rockbestos Surprenant Cable Corporation.
 - d. Draka Lifeline.
- 5. Telephone wire and cable:
 - a. American Telephone and Telegraph.
 - b. West Penn Wire.
 - c. Olympic Wire and Cable.
 - d. Superior Essex Inc.
 - e. Draka Comteq.
 - f. General Cable.
- 6. Tray cables:
 - a. General Cable, BICC Brand.
 - b. Southwire Company.
 - c. Okonite.
- 7. Armored cables.
 - a. Okonite Company.
 - b. Rockbestos Surprenant Cable Corporation.
 - c. Southwire Company.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Conductors:
 - 1. Copper in accordance with ASTM B 3.

2.04 MANUFACTURED UNITS

- A. General:
 - 1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
 - 2. Permanently mark each wire and cable with the following at 24-inch intervals:
 - a. AWG size.
 - b. Voltage rating.
 - c. Insulation type.
 - d. UL symbol.
 - e. Month and year of manufacture.
 - f. Manufacturer's name.

3. Identify and mark wire and cable as specified in Section 16075:
 - a. Use integral color insulation for Number 2 AWG and smaller wire.
 - b. Wrap colored tape around cable larger than Number 2 AWG.
- B. 600 volt class wire and cable:
1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Feeder/Branch Circuit Schedules:
 - a. When not indicated on the Drawings, size wire as follows:
 - 1) In accordance with the NEC:
 - a) Use 75 degree Celsius ampacity ratings.
 - b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
 - 2) Provide Number 12 AWG minimum for power conductors.
 - 3) Provide Number 14 AWG minimum for control conductors.
 2. Provide Class B stranding in accordance with ASTM B 8:
 - a. Provide Class C stranding where extra flexibility is required.
 3. Insulation:
 - a. XHHW-2.
 - b. 90 degrees Celsius rating.
 4. Multi-conductor cables:
 - a. Number and size of conductors as indicated on the Drawings or in the Feeder/Branch Circuit Schedules.
 - b. Individual conductors with XHHW-2 insulation.
 - c. Overall PVC jacket.
 - d. Tray cable rated.
 - e. Color-coding for control wire in accordance with ICEA Method 1, E-2 in accordance with NEMA WC 57/ICEA S-73-532.
 - f. Ground conductor: Bare or Insulated, green:
 - 1) Sized in accordance with NEC.
- C. Instrumentation class cable:
1. Type TC.
 2. Suitable for use in wet locations.
 3. Voltage rating: 600 volts.
 4. Temperature rating:
 - a. 90 degrees Celsius rating in dry locations.
 - b. 75 degrees Celsius rating in wet locations.
 5. Conductors:
 - a. Insulation:
 - 1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
 - b. Number 16 AWG stranded and tinned.
 - c. Color code:
 - 1) Pair: Black and white.
 - 2) Triad: Black, white and red.
 - 3) Multiple pairs or triads:
 - a) Color-coded and numbered.
 6. Drain wire:
 - a. 18 AWG.
 - b. Stranded, tinned.
 7. Jacket:
 - a. Flame retardant, moisture and sunlight resistant PVC.

- b. Ripcord laid longitudinally under jacket to facilitate removal.
- 8. Shielding:
 - a. Individual pair/triad:
 - 1) Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
 - b. Multiple pair or triad shielding:
 - 1) Group shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100-percent coverage.
 - 2) Completely isolate group shields from each other.
 - 3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100-percent coverage.
 - c. All shielding to be in contact with the drain wire.
- D. Network cables:
 - 1. Category 6E (Category 6 Enhanced):
 - a. General:
 - 1) Provide all Cat 6E cables meeting the most recently published standards set by ANSI/TIA/EIA for installation and testing of communication cabling and connectors.
 - b. Conductors:
 - 1) 23 AWG solid bare copper conductors.
 - c. Insulation:
 - 1) Polyolefin.
 - 2) 4 non-bonded twisted pair cables formed into a cable core.
 - d. Color code:
 - 1) Pair 1: White/blue stripe and blue.
 - 2) Pair 2: White/orange stripe and orange.
 - 3) Pair 3: White/green stripe and green.
 - 4) Pair 4: White/brown stripe and brown.
 - e. Outer jacket:
 - 1) PVC with ripcord color Blue.
 - f. Electrical characteristics:
 - 1) Frequency range: 0.772-550 MHz.
 - 2) Attenuation: 32.1 dB/100 m.
 - 3) Near-end crosstalk (NEXT): 39.3 dB.
 - 4) Power sum NEXT: 37.3 dB.
 - 5) Attenuation to crosstalk ratio (ACR): 7.2 dB.
 - 6) Power sum attenuation to crosstalk ratio (PSACR): 5.3 dB/100 m.
 - 7) Equal level far-end crosstalk (ELFEXT): 22.8 dB.
 - 8) Power sum ELFEXT: 19.8 dB/100 m.
 - 9) Return loss: 17.3 dB.
 - 10) Propagation delay: 537 ns/100 m.
 - 11) Delay skew: 45 ns/100 m.
 - 12) Propagation delay (skew), max: 2.5 ns/100 m.
 - 2. DeviceNet cable:
 - a. Provide DeviceNet cables in the following cable types as indicated on the Drawings and in the Specifications:
 - 1) Thick.
 - 2) Thin.
 - b. General:
 - 1) NEC/UL Type TC or TC-ER.

- 2) Compliant with all ODVA specifications, and shall pass the ODVA established conformance test.
 - 3) Approved to bear the ODVA Conformance Tested Service Mark.
 - c. Thick cable types shall consist of 2 shielded pairs for data and power:
 - 1) Shielded data pair:
 - a) Tinned, copper conductors minimum with 19 by 30 stranding (minimum).
 - b) Flame retardant polypropylene insulated.
 - c) Aluminum foil-polyester tape.
 - d) One pair AWG #18 for signal (minimum).
 - e) Color: Blue and white.
 - 2) Shielded DC power pair:
 - a) Tinned, copper conductors with 19 by 28 stranding (minimum).
 - b) Polyvinyl chloride insulated.
 - c) Aluminum foil-polyester tape.
 - d) One pair AWG #16 for power (minimum).
 - e) Color: Black and red.
 - 3) 100-percent coverage each pair foil shielded with overall 65-percent coverage tinned copper braid.
 - 4) Outer shield tinned copper drain wire.
 - 5) Sunlight/oil resistant polyvinyl chloride outer jacket.
 - 6) 600-volt insulation level.
 - 7) Nominal OD 0.48 inch (minimum).
 - 8) Use CPE insulated cable for direct burial.
 - d. Thin cable types shall consist of 2 shielded pairs for data and power:
 - 1) Shielded data pair:
 - a) Tinned, copper conductors with 19 by 32 stranding (minimum).
 - b) Foam polyethylene (FPE).
 - c) Aluminum foil-polyester tape.
 - d) One pair AWG #20 for signal (minimum).
 - e) Color: Blue and white.
 - 2) Shielded DC power pair:
 - a) Tinned, copper conductors with 19 by 30 stranding (minimum).
 - b) Polyvinyl chloride insulated.
 - c) Aluminum-foil polyester tape.
 - d) One pair AWG #18 for power.
 - e) Color: Black and red.
 - 3) 100 percent coverage each pair foil shielded with overall 65-percent tinned copper braid.
 - 4) Outer shield tinned copper drain wire.
 - 5) Sunlight/oil resistant polyvinyl chloride outer jacket.
 - 6) 300-volt insulation level.
 - 7) Nominal OD 0.378 inch.
3. RS-485 cable:
 - a. Two-wire:
 - 1) Shielded twisted pair.
 - 2) Tinned, copper conductors minimum with 7 by 30 stranding.
 - 3) AWG #22.
 - 4) Insulation:
 - a) FHDPE: Foam high-density polyethylene.
 - b) 300-volt insulation level.

- 5) Outer shield:
 - a) 100-percent coverage.
 - b) Tape/braid.
 - c) Aluminum foil-polyester tape.
 - d) Tinned copper braid.
- 6) Outer shield drain wire:
 - a) Tinned, copper conductor minimum with 7 by 30 stranding.
 - b) AWG #22.
- 7) Outer jacket PVC:
 - a) Sunlight resistant.
- 8) UL/CSA flame tested.
- 9) Minimum bending radius 2.5 inches.
- 10) Nominal OD 0.284 inch.

E. Tray cable:

1. Provide minimum size Number 1/0 AWG for single wires:
 - a. Listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with the NEC.
2. Provide multi-conductor cable listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with the NEC.
 - a. Provide with an integral white insulated conductor where a neutral is required.
3. Ambient temperature adjustment in accordance with the NEC.

F. Fire alarm cable:

1. Number of pairs: As necessary for the application.
2. Voltage rating: 300 V minimum.
3. Two-hour fire rating in accordance with UL 2196.
4. Provide fire alarm cable in accordance with the requirements of UL 1424.
5. Provide Type FPLP (power-limited plenum rated) for all cabling within ducts, plenums, and all spaces used for air handling:
 - a. Cable must meet NEC standards, and must have adequate fire-resistant and low smoke-producing characteristics.
6. Provide Type FPLR (power-limited riser rated) for all vertical runs that pass from floor to floor:
 - a. FPLR cable must meet NEC standards, and must have fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.
7. FPL (power-limited general purpose) is only suitable for general-purpose fire alarm use and shall not be used for risers, ducts, plenums, and in air-handling spaces:
 - a. FPL cable must meet NEC standards, and must be listed as resistant to the spread of fire.
8. Cable substitutions are not permitted unless approved by Engineer.
9. Meets code requirements of NFPA 72 and NFPA 101.
10. Conductor insulation:
 - a. Low smoke PVC.
 - b. Minimum 105 degrees Celsius rating.
11. Conductor jacket:
 - a. Low smoke PVC.
 - b. Ripcord and surface-printed with year of manufacture and cable description at maximum 24-inch intervals.
 - c. Minimum 105 degrees Celsius rating.

- G. Telephone cable:
 - 1. Number of twisted pairs: As indicated on the Drawings.
 - 2. Voltage rating: 300 volts.
 - 3. Insulation: Thermoplastic, color coded in accordance with telephone industry standards.
 - 4. Insulation:
 - a. Non-plenum: High molecular weight polyethylene.
 - b. Plenum-rated: FEP.
 - 5. Jacket:
 - a. Non-plenum: PVC.
 - b. Plenum-rated: Low smoke PVC.
 - c. Surface-printed with year of manufacture and cable description at maximum 24-inch intervals.
 - 6. Shield: 8 mil aluminum or copper, overlapped to provide 100-percent coverage, covered totally on both sides with copolymer or equal coating able to provide an effective moisture barrier.
 - 7. Conductors: ASTM B3, solid, soft, bare copper.
 - 8. Use minimum Number 24 AWG conductors, unless otherwise indicated on the Drawings.
 - 9. Twist insulated conductors into pairs with varying lengths of lay.
 - 10. Apply non-hygroscopic core tape over cable core as a dielectric and heat barrier.
 - 11. Provide plenum-rated cable for wiring within ducts, plenums, and all spaces used for air handling.

- H. Armored cable:
 - 1. Tight-fitting, continuously welded, corrugated impervious aluminum armor sheath applied over the cable core in accordance with UL 1569.
 - 2. PVC outer jacket.
 - 3. Comply with UL-2225 if within hazardous classification area.
 - 4. For multi-conductor cable, include a separate ground conductor in the cable:
 - a. An internal ground conductor shall meet NEC requirements for equipment ground conductor size.
 - b. The cable armor is not acceptable as a ground conductor.
 - 5. Rated for 90 degrees Celsius in wet or dry locations.
 - 6. Color-coding for control wire in accordance with ICEA Method 1, E-2.
 - 7. Color-coding for power cables as specified above.
 - 8. Individual conductors in accordance with this Specification:
 - a. Provide the number and size of conductors as indicated on the Drawings.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Wire ties:
 - 1. One of the following or equal:
 - a. T&B "Ty-Rap" cable ties.
 - b. Panduit cable ties.

- B. Wire markers:
 - 1. As specified in Section 16075.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.
- B. Test Type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000.
- B. Color-coding:
 - 1. Color-coding shall be consistent throughout the facility.
 - 2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
 - a. Phase A – Black.
 - b. Phase B – Red.
 - c. Phase C – Blue.
 - d. Single phase system – Black for one hot leg, red for the other.
 - e. Neutral – White.
 - f. High phase or wild leg – Orange.
 - g. Equipment ground – Green.
 - 3. The following color code shall be followed for all 480/277 volt systems:
 - a. Phase A – Brown.
 - b. Phase B – Orange.
 - c. Phase C – Yellow.
 - d. Neutral – Gray.
 - e. Equipment ground – Green.
 - 4. The following color code shall be followed for all 120 VAC control wiring:
 - a. Power – Red.
 - b. Neutral – White.
 - 5. The following color code shall be followed for all general purpose DC control circuits:
 - a. Grounded conductors – White with blue stripe.
 - b. Ungrounded conductors – Blue.
 - 6. Switch legs shall be violet. Three-way switch runners shall be pink.
 - 7. Wires in intrinsically safe circuits shall be light blue.

8. Wire colors shall be implemented in the following methods:
 - a. Wires manufactured of the desired color.
 - b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
 - 1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.
- C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
 1. Install wires only in approved raceways.
 2. Do not install wire:
 - a. In incomplete conduit runs.
 - b. Until after the concrete work and plastering is completed.
- D. Properly coat wires and cables with pulling compound before pulling into conduits:
 1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
 - a. Ideal Products.
 - b. Polywater Products.
 - c. 3M Products.
 - d. Greenlee Products.
 - e. Or equal as recommended by cable manufacturer.
 - f. Do not use oil, grease, or similar substances.
- E. Cable pulling:
 1. Prevent mechanical damage to conductors during installation.
 2. For cables Number 1 AWG and smaller, install cables by hand.
 3. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
 4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the ENGINEER may, at his discretion, require replacement of the cable.
 5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.
 6. Make splices or add a junction box or pull box where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer's recommendation for the specified cable size:
 - a. Make splices in manholes or pull boxes only.
 - b. Leave sufficient slack to make proper connections.
- F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.
- G. Install and terminate all wire in accordance with manufacturer's recommendations.
- H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
 1. Do not lace wires in gutter or panel channel.
 2. Install all wire ties with a flush cutting wire tie installation tool:
 - a. Use a tool with an adjustable tension setting.
 3. Do not leave sharp edges on wire ties.

- I. Terminate solid conductors at equipment terminal screws with the conductor tightly wound around the screw so that it does not protrude beyond the screw head:
 - 1. Wrap the conductor clockwise so that the wire loop is closed as the loop is tightened.
 - 2. Do not use crimp lugs on solid wire.

- J. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
 - 1. Use ring type lugs if box lugs are not available on the equipment.

- K. Splices:
 - 1. Provide continuous circuits from origin to termination whenever possible:
 - a. Obtain Engineer's approval prior to making any splices.
 - 2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
 - 3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
 - a. Splice box NEMA rating requirements as specified in Section 16050.
 - b. Make splices in labeled junction boxes for power conductors.
 - c. Make splices for control and instrument conductors in terminal boxes:
 - 1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
 - 4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
 - 5. Clearly label junction and terminal boxes containing splices with the word "SPLICE."
 - 6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
 - 7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
 - a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
 - 8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
 - a) A heat shrink insulating system listed for submersible applications.
 - b) Or an epoxy resin splicing kit.

- L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

- M. Instrumentation class cable:
 - 1. Install instrumentation class cables in separate raceway systems from power cables:
 - a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
 - b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
 - 2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
 - 3. Shield grounding requirements as specified in Section 16060.

- N. Multi-conductor cable:
 - 1. Where cable is not routed in conduit with a separate ground conductor, use one conductor in the cable as a ground conductor:
 - a) Use an internal ground conductor, if it is no smaller than as indicated on the Drawings and in accordance with NEC requirements for equipment ground conductor size.
 - b) Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.

- O. Armored cable:
 - 1. Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with 1 of the full-sized conductors serving as ground.
 - 2. The cable armor is not acceptable as a ground conductor.
 - 3. Where armored cable terminates at a device, switchboard, panel, etc., use armored cable connector.
 - 4. Where armored cable run continues in conduit, strip jacket and armor for portions in conduit, and terminate cable and jacket with an armored cable connector threaded into a coupling or conduit box.

- P. Telephone cable:
 - 1. Install telephone cables in dedicated metallic raceways, including raceways in ductbanks, manholes, and pull boxes.

- Q. Fire alarm cable:
 - 1. Install fire alarm cable in dedicated metallic raceways as indicated on the Drawings.

- R. Signal cable:
 - 1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

- S. Submersible cable in wet wells:
 - 1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

- T. Wiring allowances:
 - 1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
 - 2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

B. Grounding:

1. As specified in Section 16060.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16000.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16134

BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Device boxes.
 - 2. Raceway system boxes.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – General Electrical Specifications.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. ASTM International (ASTM):
 - 1. A 47 – Standard Specification for Ferritic Malleable Iron Castings.
 - 2. D 149 – Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
 - 3. D 495 – Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
 - 4. D 570 – Standard Test Method for Water Absorption of Plastics.
 - 5. D 648 – Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
 - 6. D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 7. D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

- C. Joint Industry Conference (JIC).

- D. Underwriters Laboratories, Inc. (UL):
 - 1. 94 – Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

- A. As specified in Section 16000.
- B. Specific definitions:
 - 1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
 - 2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SYSTEM DESCRIPTION

- A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.
- B. Provide boxes and conduit bodies as indicated on the Drawings or as needed to complete the raceway installation.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 and 16050.
- B. Product data:
 - 1. Manufacturer.
 - 2. Materials.
 - 3. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 - d. Weight.
 - e. NEMA rating.
 - 4. Conduit entry locations.
 - 5. Catalog cut sheets.
 - 6. Installation instructions.
- C. Shop drawings:
 - 1. Include identification and sizes of pull boxes.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16050.
- B. Regulatory requirements:
 - 1. Outlet boxes shall comply with all applicable standards of:
 - a. JIC.
 - b. NEC.
 - c. NEMA.
 - d. UL.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16000.

1.09 SEQUENCING

A. As specified in Section 16000.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16000.

1.12 SYSTEM START-UP

A. As specified in Section 16000.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
1. Pressed steel boxes:
 - a. Steel City.
 - b. Appleton.
 - c. Crouse – Hinds.
 - d. Thomas & Betts.
 2. Plastic and/or fiberglass boxes:
 - a. Hoffman.
 - b. Carlon.
 - c. Stahlin.
 3. Plastic coated steel boxes:
 - a. Rob Roy.
 - b. OCAL.
 4. Cast device boxes:
 - a. Appleton.
 - b. Crouse – Hinds.
 - c. OZ/Gedney.
 5. Floor outlet boxes with 1 inch conduit knockouts:
 - a. Steel City, 640 Series.
 - b. Hubbell type B25 with S2530 cover plate.
 6. Floor outlet boxes in open areas:
 - a. Hubbell SC-3098 with plate SS-309-D for power.
 - b. Hubbell SC-3098 with plate SS-309-T for telephone.

7. Formed steel enclosures:
 - a. Hoffman.
 - b. Thomas and Betts.
 - c. Stahlin.
 - d. Rittal.
8. Stainless steel enclosures:
 - a. Hoffman.
 - b. Stahlin.
 - c. Rittal.
9. Pressed steel boxes and concrete boxes:
 - a. Appleton.
 - b. Steel City.
 - c. Cooper/Crouse Hinds.
 - d. OZ Gedney.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Pressed steel boxes:
 1. One-piece galvanized pressed steel.
 2. Knockout type boxes.
 3. Minimum size 4 inch square by 2-1/8 inch deep.
- B. Concrete boxes:
 1. For outlets and pull boxes in concrete construction.
 2. Pressed steel or cast construction, concrete tight.
 3. Knockout sizes range from 1/2 inch to 1 inch.
 4. Depth as needed.
 5. Types:
 - a. Four inch octagon.
 - b. Four inch octagon ceiling boxes with hanging bars.
 - c. Gangable masonry boxes:
 - 1) 3-1/2 inch deep, 3-3/4 inch high, length as required:
 - a) 2-1/2 inch deep boxes may be used where wall thickness precludes the use of the deeper boxes.
 - 2) With partitions as needed.
- C. Threaded-hub boxes:
 1. Construction:
 - a. With internal green ground screw.
 - b. Furnished with a suitable gasketed cover.
 - c. With integral cast mounting lugs when surface mounted.
 - d. Conduit sizes range from 3/4 inch to 1 inch.
 - e. Tapered threaded hubs with integral bushing.
 2. Aluminum (copper free) boxes:
 - a. High strength copper free 4/10 of 1 percent maximum alloy for use with aluminum rigid conduit.
 3. Malleable iron boxes:
 - a. Conforming to ASTM A 47 Grade 32510.

- D. Plastic coated threaded-hub boxes:
 - 1. Construction:
 - a. With internal green ground screw.
 - b. Furnished with a suitable gasketed cover.
 - c. With integral cast mounting lugs when surface mounted.
 - d. Conduit sizes range from 3/4 inch to 1 inch.
 - e. Double coated with a nominal 0.002 inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
 - f. With a minimum 0.040 inch (40 mil) PVC coating bonded to exterior.
 - g. With pressure sealing sleeve to protect the connection with conduit.

- E. Class I Division 1 areas:
 - 1. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
 - a. The approval ratings must be permanently marked on each item.

- F. Class I, Division 2 areas:
 - 1. For boxes not containing arcing parts:
 - a. As specified in Section 16000.
 - b. Pressed metal boxes are not allowed.
 - 2. For boxes containing arching parts provide:
 - a. Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
 - 1) The approval ratings must be permanently marked on each item.
 - 3. Cast iron box and cover.
 - 4. Precision machined flame path between box and cover with neoprene O-ring.
 - 5. Bolt-on stainless steel slotted mounting feet for horizontal or vertical mounting.
 - 6. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
 - 7. External flange.
 - 8. Provisions for mounting pan.
 - 9. Ground lug.

- G. Fiberglass boxes:
 - 1. NEMA Type 4X.
 - 2. Constructed of molded fiberglass reinforced polyester.
 - 3. Integral neoprene gasket on cover attached with an oil-resistant adhesive.
 - 4. Enclosures to have internal pads for mounting optional panels and terminal kits.
 - 5. Covers:
 - a. Screw cover enclosures:
 - 1) Covers held in place with captive, stainless steel, or Monel screws.
 - 2) Covers attached to body with internal zinc-plated steel hinges.
 - b. Quick release latches covers:
 - 1) Corrosion resistant fiberglass hinges.
 - 2) Spring loaded fiberglass latches with a Monel or stainless steel bail attached with Monel or stainless steel screws.
 - 3) With a Type 316 stainless steel padlock hasp.
 - 6. With external mounting feet.
 - 7. Meeting the following minimum standards and tests:

Physical Property	Value	ASTM Method
Flexural strength	12,000 psi	D 790
Heat distortion	400° Fahrenheit	D 648
Water absorption (24 hrs)	0.5 percent	D 570
Tensile strength	5000 psi	D 651
Specific gravity	1.8	D 792
Flammability	94V-0	UL 94
Dielectric strength	4000 V.P.M.	D 149
Arc resistance	180 second	D 495

H. Formed steel enclosures:

1. Steel:

- a. NEMA Type 12.
- b. Fabricated from 14-gauge steel, minimum.
- c. All seams continuously welded ground smooth.
- d. Door:
 - 1) Rolled lip around 3 sides.
 - 2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
- e. Neoprene door gasket to provide a watertight, dust-tight, oiltight seal:
 - 1) Attached with an adhesive.
 - 2) Retained by a retaining strip.
- f. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
 - 1) With a hasp and staple for padlocking.
- g. Provide large enclosures with door and body stiffeners for extra rigidity.
- h. No holes or knockouts.
- i. Finish:
 - 1) ANSI-61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
 - 2) White electrostatically applied polyester powder mounting plate.
- j. Heavy gauge steel external mounting brackets when surface mounted.

2. Stainless steel:

- a. NEMA Type 4X:
 - 1) Boxes in locations subject to flooding or temporary submersion:
 - a) NEMA Type 6.
- b. Fabricated from 14-gauge Type 316 stainless steel.
- c. All seams continuously welded.
- d. Door:
 - 1) Rolled lip around 3 sides.
 - 2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
- e. Neoprene door gasket to provide a watertight seal:
 - 1) Attached with an adhesive.
 - 2) Retained by a retaining strip.
- f. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
 - 1) With a hasp and staple for padlocking.

- g. Provide large enclosures with door and body stiffeners for extra rigidity.
 - h. No holes or knockouts.
 - i. Finish:
 - 1) Brushed.
 - j. Stainless steel external mounting brackets when surface mounted.
- I. Cast iron junction boxes:
- 1. NEMA Type 4.
 - 2. Recessed cover boxes.
 - 3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
 - 4. Designed for flush mounting in walls or floors:
 - a. Can be surface mounted using mounting lugs.
 - 5. Construction:
 - a. Cast iron box.
 - b. Covers:
 - 1) Checkered plate covers suitable for foot traffic.
 - 2) When used in areas subject to vehicular traffic H-20 loading.
 - c. Hot dip galvanized.
 - d. Neoprene gasket.
 - e. Stainless steel screw covers.
- J. Floor outlet boxes:
- 1. Watertight cast iron, semi adjustable.
 - 2. Telephone outlets shall be fitted with 6 inch bushed nipples.
 - 3. Provide a pedestal housing for floor outlets in open areas.
 - 4. Suitable for receptacles, communications, and data outlets as specified and indicated on the Drawings, complete with gaskets and cover plates:
 - a. Dual-gang, heavy-duty cast iron, suitable for wiring devices to be installed to make a complete and operable system and installation.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Fasteners:
- 1. Electroplated or stainless steel in boxes with wiring devices.
 - 2. Screws, nuts, bolts, and other threaded fasteners:
 - a. Stainless steel.
- B. Provide breather and drain fittings where appropriate.
- C. Internal panels:
- 1. Provide internal panels where required for mounting of terminal strips or other equipment.
 - 2. With plated steel shoulder studs.
 - 3. Steel with white polyester powder finish.
- D. Floor stand kit when shown:
- 1. Fabricated from 12-gauge steel.
 - 2. Bottom plate 11 gauge.

3. Heights:
 - a. 12 inches.
4. Do not provide external mounting brackets, when a floor stand kit is used.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000.
- B. General:
 1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 16050.
 2. Provide outlet box materials to match the conduit system:
 - a. EMT – Pressed metal boxes.
 - b. GRC – Cast ferrous boxes.
 - c. RAC – Aluminum (copper free) boxes.
 - d. PCS – PVC coated cast ferrous boxes.
 - e. PVC – PVC boxes.
 - f. PCA – PVC coated aluminum boxes.
 3. Solid type gang boxes:
 - a. For more than 2 devices.
 - b. For barriered outlets.
 4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8 inch free air space between the back of the enclosure and the wall:
 - a. Use machined spacers to maintain air space; built-up washers are not acceptable.
 - b. Use stainless steel or nylon materials for spacers.
 5. Use cast malleable iron boxes when box must support other devices.
 6. Boxes serving luminaires or devices:
 - a. Use as pull boxes wherever possible.
 7. In finished areas:
 - a. Provide specific pull or junction boxes only as indicated on the Drawings or as directed.
 8. Fit all cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.
 9. In terminal boxes, furnish terminals as indicated on the Drawings, with a minimum of 50 percent spare terminals:
 - a. Furnish wireways for discrete and analog/DC wiring.
 - b. Separate analog wiring from 120 V discrete or power wiring.

10. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.
11. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

C. Outlet boxes:

1. Locate outlet boxes as indicated on the Drawings:
 - a. Adjust locations so as not to conflict with structural requirements or other trades.
2. Use deep threaded-hub malleable iron or aluminum boxes:
 - a. In hazardous areas.
 - b. Where exposed to the weather.
 - c. In unheated areas.
 - d. Where subject to mechanical damage:
 - 1) Defined as exposed boxes less than 10 feet above the floor.
 - e. To act as a pull box for conductors in a conduit system.
 - f. Accommodate wiring devices.
3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
4. Outlet boxes may be used as junction boxes wherever possible.

D. Pull boxes and junction boxes:

1. Size pull boxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
2. Install pull boxes such that access to them is not restricted.

E. For boxes not indicated:

1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations:
 - a. One-piece, galvanized, pressed steel.
3. Ceiling boxes for flush mounting in concrete:
 - a. Deep, galvanized, pressed steel.
4. Outlet, switch, and junction boxes where surface mounted in exposed locations:
 - a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
5. Outlet, control station, and junction boxes for installation in corrosive locations:
 - a. Fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system.
 - b. Furnished with mounting lugs.
6. Boxes for concealed conduit system:
 - a. Non-fire rated construction:
 - 1) Depth: To suit job conditions and comply with the NEC.
 - 2) For luminaries: Use outlet boxes designed for the purpose:
 - a) 50 pounds or less: Box marked "For Fixture Support."
 - b) More than 50 pounds: Box listed and marked with the weight of the fixture to be supported (or support luminaire independent of the box.)

- 3) For junction and pull boxes: Use galvanized steel boxes with flush covers.
- 4) For switches, receptacles, etc.:
 - a) Plaster or cast-in-place concrete walls: Use 4 inch or 4-11/16 inch galvanized steel boxes with device covers.
 - b) Walls other than plaster or cast-in-place concrete: Use type of galvanized steel box which will allow wall plate to cover the opening made for the installation of the box.
7. Recessed boxes in fire rated (2 hours maximum) bearing and nonbearing wood or steel stud walls (gypsum wallboard facings):
 - a. Use listed single and double gang metallic outlet and switch boxes.
 - 1) The surface area of individual outlet or switch boxes shall not exceed 16 square inches.
 - b. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet of wall surface.
 - c. Securely fasten boxes to the studs.
 - 1) Verify that the opening in the wallboard facing is cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.
 - d. Separate boxes located on opposite sides of walls or partitions by a minimum horizontal distance of 24 inches.
 - 1) This minimum separation distance may be reduced when wall opening protective materials are installed according to the requirements of their classification.
 - e. Use wall opening protective material in conjunction with boxes installed on opposite sides of walls or partitions of staggered stud construction in accordance with the classification requirements for the protective material.
8. Other fire rated construction: Use materials and methods to comply with the listing requirements for the classified construction.

F. Recessed boxes:

1. Support recessed boxes in suspended ceilings or stud partitions with galvanized steel box hangers of types made specifically for the purpose or attach directly to wood members or blocking.
2. Secure hangers or boxes to wood with 1 inch long cadmium-plated Type A pan head screws:
 - a. Fully or partially hammer-driven screws are not acceptable.

G. Hazardous locations:

1. All metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
2. All threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
3. Conduits entering and exiting metallic boxes in Class I Division 2 areas shall utilize approved grounding bushings to bond the conduits together.
4. Provide the following types of conduit bodies and boxes:
 - a. Malleable iron bodies and boxes with GRC or IMC conduit systems.
 - b. PVC coated conduit bodies and boxes with PCS conduit systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 16000.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 16000.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16000.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Switches.
 - 2. Receptacles.
 - 3. Plates.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – General Electrical Specifications

1.02 REFERENCES

- A. As specified in Section 16000.

- B. Federal Specifications (FS):
 - 1. W-C 596 – Connector, Electrical, Power, General Specification for.
 - 2. W-S 896/2 – Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

- C. National Electrical Manufacturers Association (NEMA):
 - 1. WD1 – General Color Requirements for Wiring Devices.
 - 2. ICS 5 – Industrial Control and Systems, Control Circuit and Pilot Devices.
 - 3. OS1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. WD6 – Wiring Devices Dimensional Specifications.

- D. National Fire Protection Association (NFPA):
 - 1. 70 – National Electric Code (NEC).

- E. Underwriters Laboratories Inc. (UL):
 - 1. 20 – General Use Snap Switches.
 - 2. 498 – Standard for Attachment Plugs and Receptacles.
 - 3. 514D – Cover Plates for Flush-Mounted Wiring Devices.
 - 4. 943 – Ground-Fault Circuit-Interrupters.
 - 5. 1472 – Solid State Dimming Controls.

1.03 DEFINITIONS

- A. As specified in Section 16000.
- B. Specific definitions:
 - 1. GFCI: Ground fault circuit interrupter.
 - 2. P-S: Pass and Seymour.
 - 3. Cooper: Cooper Wiring Devices, a division of Cooper Industries.
 - 4. T&B: Thomas and Betts.

1.04 SYSTEM DESCRIPTION

- A. Switches, receptacles, and plates as indicated on the Drawings wired and operable to form a complete system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications
- B. Product data:
 - 1. Catalog cut sheets.
- C. Shop drawings:
 - 1. Engraving schedule:
 - a. Furnish complete engraving schedule for engraved nameplates.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000.
- B. Wiring devices shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16000.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000.

1.12 SYSTEM START-UP

- A. As specified in Section 16000.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switches:

1. General purpose switches: One of the following or equal:
 - a. Hubbell.
 - b. Leviton.
 - c. Cooper.
2. Switches for office areas: One of the following or equal:
 - a. Hubbell.
 - b. Leviton.
 - c. Cooper.
3. Switches for photocells: One of the following or equal:
 - a. Hubbell.
 - b. Cooper.
4. Switches for hazardous areas: One of the following or equal:
 - a. Appleton.
 - b. Crouse-Hinds.
5. Occupancy Sensor Switches: The following or equal:
 - a. WattStopper.
 - b. Cooper.
6. Dimmer switches: The following or equal:
 - a. Lutron.
 - b. Cooper.

B. Receptacles:

1. General purpose receptacles: One of the following or equal:
 - a. Hubbell.
 - b. Leviton.
 - c. Cooper.
2. Receptacles for hazardous areas: One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
3. 250 VAC receptacles: One of the following or equal:
 - a. Hubbell.
 - b. Cooper.
4. 480-Volt, 3-phase receptacles: One of the following or equal:
 - a. Crouse-Hinds.
 - b. Hubbell.
 - c. RussellstoTM.

C. Plates:

1. General location: The following or equal:
 - a. P-S.
 - b. Cooper.

2. Wet or corrosive areas: One of the following or equal:
 - a. Hubbell.
 - b. Cooper.
 - c. T&B.
 - d. P-S.
3. In-use covers: One of the following or equal:
 - a. TayMac.
 - b. Cooper.
 - c. P-S.
 - d. T&B.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Switches:
 1. General:
 - a. 120-277 VAC.
 - b. 20 ampere.
 - c. Listed in accordance with UL 20.
 - d. Designed and constructed in accordance with FS W-S-896/2.
 - e. Back and side wired unless otherwise indicated.
 - f. Integral grounding terminal.
 - g. Totally enclosed:
 - 1) Color-coded body with color corresponding to ampere rating.
 - h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
 - i. Color:
 - 1) Ivory in finished areas.
 - 2) Brown in all other areas.
 2. General purpose switches:
 - a. Toggle type.
 3. Switches for office areas:
 - a. Rocker type.
 - b. Rectangular.
 4. Switches for use with photocell:
 - a. Maintained contact.
 - b. Two circuit.
 - c. Three position:
 - 1) Center off.
 5. Switches for hazardous areas:
 - a. Suitable for use in Class I Division 1 and Class I Division 2 locations.
 - b. Factory sealed.
 - c. Through-feed or dead-end as required.
 6. Occupancy sensor switches:
 - a. Wall switch with dual-technology passive infrared and ultrasonic sensor.
 - 1) Configured such that lights turn on only when both infrared and ultrasonic sensors detect activity, but do not turn off as long as either sensor detects activity.

- b. Selectable “automatic-on” mode activated by sensors or “manual-on” mode activated by pushbutton.
 - c. Adjustable 5-30 minute time delay.
 - d. Selectable audible alert as a warning before lights turn off.
 - e. Rated for fluorescent lighting loads of up to 800W.
 - f. True multi-way switching allowing identical controls at any location for multi-way switching applications.
7. Dimmer switches:
- a. Shall be rectangular design with LED light level indicators.
 - b. Suitable for use with type of lamp switched.

B. Receptacles:

- 1. General purpose receptacles:
 - a. Single or duplex as indicated on the Drawings.
 - b. 125 VAC.
 - c. 20 ampere or as indicated on the Drawings.
 - d. NEMA Type 5-20R configuration for 20 ampere receptacles.
 - e. Other NEMA configurations as indicated on the Drawings.
 - f. Listed in accordance with UL 498.
 - g. Designed and constructed in accordance with FS W-C-596.
 - h. Back and side wired.
 - i. One-piece, rivet-less mounting strap.
 - j. Color:
 - 1) Ivory in finished areas.
 - 2) Brown in all other areas.
 - 3) Orange when powered by a UPS.
- 2. Ground fault interrupter receptacles (GFCI):
 - a. 125 VAC.
 - b. 20 ampere.
 - c. Trip level 4-6 milliampere.
 - d. Individual and feed through protection.
 - e. UL 943 and UL 498 listed.
 - f. NEMA Type 5-20R configuration.
 - g. For damp or wet locations:
 - 1) Weather resistant, in accordance with UL 498.
- 3. Isolated:
 - a. Duplex as indicated on drawings.
 - b. 125 VAC.
 - c. 20 ampere.
 - d. Isolated and insulated from box.
- 4. Receptacles for hazardous areas (As per NFPA 820):
 - a. 125 VAC.
 - b. 20 ampere.
 - c. Factory sealed.
 - d. Single receptacle.
 - e. 2-wire, 3-pole.
 - f. Grounded through extra pole and shell.
 - g. Dead-front construction.
 - h. Interlocked to prevent plug from being withdrawn until circuit has been broken.

5. 25 0 VAC receptacles:
 - a. 2-pole, 3-wire grounding for 240 VAC circuits.
 - b. 3-pole, 4-wire grounding for 208 VAC 3-phase circuits.
 - c. Ampere rating as indicated on the Drawings.
 - d. Provide NEMA configuration as required by the equipment connected to the outlet.
6. 48 0 VAC receptacles:
 - a. 3-pole, 4-wire grounding.
 - b. Ampere rating as indicated on the Drawings.
 - c. Spring door on receptacle.
 - d. Furnish one matching plug for each 480-volt power receptacle.
7. All outdoor receptacles not in hazardous areas shall be weather proof GFI type (5-20R).
8. Receptacles in Classified locations shall be Explosion Proof, Hazardous Location Rated, 20 amp, 125 VAC/250 VAC, 5-20R. Receptacle shall be ANSI/UL943, 1203 listed.

C. Plates:

1. General location:
 - a. Type 302 or 304 stainless steel.
 - b. Brushed satin finish.
 - c. Minimum thickness: 0.032 inches.
 - d. Rectangular or square shape.
 - e. Engraving:
 - 1) Engrave each plate with the following information:
 - a) Area served.
 - b) Circuit number.
 - 2) Treat engraving to improve visibility and, except for stainless steel plates, to prevent corrosion.
 - 3) Characters shall be block letter pantograph engraved with a minimum character height of 1/8-inch.
 - f. Coordinate the number of gangs, number and type of openings with the specific location.
2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
 - a. General:
 - 1) UL listed for wet locations.
 - 2) Gasketed.
 - 3) Die cast metal:
 - a) Match material to box material.
 - b. Switches:
 - 1) Lever operated:
 - a) Provide toggle switch.
 - c. Receptacles:
 - 1) Weather proof in-use cover:
 - a) Die cast metal construction with electrostatic powder coating for corrosion resistance.
 - b) Gasketed.
 - c) Lockable.
 - d) UL listed and in accordance with NEC.

3. Corrosive areas:
 - a. Neoprene.
 - b. Gasketed.
 - c. Weatherproof.

- D. Data and communications jacks:
 - a. Process network jacks – panel/enclosure mounted:
 - 1) Network jacks located in process areas shall have a NEMA Type 4 rating (with closure cap).
 - 2) Mounting of network jacks in control panels shall be accomplished using bulkhead connectors and environmental enclosure caps, which are permanently attached to the bulkhead fitting.
 - 3) Network jacks shall have RJ-45 connections on both sides of connector (bulkhead pass through) allowing for direct connection to the network switch and computer with standard patch cords. No punch down PC board connections shall be allowed.
 - 4) Manufactured by Woodhead Connectivity RJLNXX.
 2. Process network jacks – conduit body mounted:
 - a. Network jacks located in process areas shall have a NEMA Type 4 rating (with closure cap).
 - b. Mounting of network jacks in conduit bodies adapter (with Minifast connector) shall be accomplished using conduit body insert and environmental enclosure caps.
 - c. PC board connections are not to be allowed.
 - d. Furnish 10 RJ-45 to minifast connector patch cable 3 feet in length.
 - e. Manufactured by InterlinkBT RSS series.
 3. Network/phone jacks:
 - a. Network jacks located in computer rooms shall be installed per the installation details indicated on the Drawings.
 - b. Standard Decora wall plates shall be used with QuickPort modules and inserts.
 - c. Plugs shall be color coded as indicated in the installation details indicated on the Drawings.
 - d. Manufactured by Leviton Quickport series.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000.
- B. Mounting heights:
 - 1. Process and production areas:
 - a. Switches and receptacles 48 inches from finished floor to top of plate.
 - 2. Offices and finished areas:
 - a. Switches: 48 inches from finished floor to top of plate.
 - b. Receptacles: 18 inches from finished floor to center of plate.
- C. Switches:
 - 1. Over 300 Volts:
 - a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.
- D. Receptacles:
 - 1. Provide GFCI receptacles as indicated on the Drawings.
 - a. Provide weather resistant GFCI receptacles in all wet or damp areas.
 - 1) As specified in Section 16050.
 - 2. Mount non-weatherproof receptacles vertically:
 - a. Ground slot down.
 - 3. Mount weatherproof receptacles horizontally:
 - a. Neutral slot up.
 - 4. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.
- E. Ensure all plates make a firm seal with wall for recessed mounted devices:
 - 1. Outside edges of plates parallel with building lines.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16000.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 16000.

- B. Demonstrate the following to the Engineer and Owner:
 - 1. Switching is as indicated on the Drawings.
 - 2. All circuits conform to the panel schedules.
 - 3. All ground fault receptacles operate at levels below or equal to OSHA maximum allowable fault levels.

3.11 PROTECTION

- A. As specified in Section 16000.

3.12 SCHEDULES (NOT USED)

END OF SECTION

**SECTION 16264
VARIABLE FREQUENCY DRIVES**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Clean power 18 pulse variable frequency drives (VFD), for control of standard NEMA Design B squirrel cage induction motors.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – Common Work Results for Electrical.

1.02 REFERENCES

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

- B. National Electrical Manufacturers Association (NEMA):
 - 1. 250 – Enclosures for Electrical Equipment (1,000 volts maximum).
 - 2. MGI, Part 31 – Motors with higher peak voltage capability.

- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 519-1992 – IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

- D. Underwriters' Laboratories (UL):
 - 1. 50 Standards for Enclosures for Electrical Equipment.
 - 2. 508A Standard for Safety for Industrial Control Panels.
 - 3. 508C Standard for Power Conversion Equipment.

1.03 DEFINITIONS

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

- B. Specific definitions:
 - 1. PCC: Point of common coupling: The point of common coupling for all harmonic calculations and field measurements for both voltage and current distortion is defined as the input terminals to the VFD.

1.04 SYSTEM DESCRIPTION

A. Design requirements:

1. Each VFD system shall consist of all components required to meet the performance, protection, safety, testing, and certification criteria of this Section. All VFD's shall be sized the next size up for the intended motor load.
2. The VFD system:
 - a. Is a fully integrated package.
 - b. Includes all material necessary to interconnect VFD system elements, even if shipped separately.
3. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer.
4. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete package by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
5. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics:
 - a. The VFD Manufacturer shall furnish equipment necessary to mitigate potential damage to motor insulation.
 - b. Any VFD installed more than 100' from the motor (measurement of conductors) shall be installed with a dV/dT output line reactor. Installed in the vicinity of the VFD as per manufacture's recommendations.
6. The VFD manufacturer shall provide all required filtration to allow the VFD to operate at its full range of operation. Contactors shall not be allowed to control the filtrations devices that will allow for windows of operation with limited to no filtration.

B. Performance:

1. Operating envelope:
 - a. Speed and torque requirements:
 - 1) Provide a **variable torque** VFD as required by the driven load.
 - 2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 110 percent (25 to 66 Hertz) speed range.
 - b. Current requirements:
 - 1) Provide 100 percent of rated output current on a continuous basis.
 - 2) Variable torque VFD:
 - a) Minimum 110 percent current overload for 1 minute.
2. Harmonics:
 - a. The VFD shall comply with IEEE 519-1992 for total harmonic and current distortion calculations and measurements. The VFD shall meet the following distortion limits:
 - 1) Voltage harmonics: Individual or simultaneous operation of the VFD(s) shall not add more than 3 percent total harmonic voltage distortion while operating from the utility source or more than 5 percent total harmonic voltage distortion while operating from standby generation at the PCC.
 - 2) Current harmonics: The maximum allowable total harmonic current distortion limit for each VFD shall not exceed 5 percent as measured at the PCC.

3. Efficiency:
 - a. VFD system minimum efficiency shall be 95 percent at rated output.
VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

- b. Power:
 - 1) Load power is the total 3-phase power measured at the output terminals of the drive system, including VFD, output filters, or transformers.
 - 2) Supply power is the total power measured at the input terminals of the VFD including input filters, line reactors, phase shifting transformer, harmonic distortion attenuation equipment, and auxiliary equipment (e.g., controls, fans) for complete system operation.
4. Total power factor:
 - a. Minimum of 0.96 lagging across the entire speed range.
 - b. Under no operating conditions shall the VFD have a leading power factor.
5. Frequency accuracy:
 - a. Minimum of within 0.01 percent.
6. Speed regulation:
 - a. Minimum of within 0.5 percent across the entire speed range.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the plans and specifications:
 1. Custom prepared by the VFD Manufacturer and specific for the equipment furnished.
- B. Product data:
 1. Manufacturer of the VFD.
 2. Manufacturer of all components of the VFD.
 3. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 4. Weight.
 5. Nameplate schedule.
 6. Bill of material.
 7. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Input current.
 - d. Output current.
 - e. Interrupting rating.
 - f. Momentary current rating.
 8. Catalog cut sheets for major components.
 9. Design data:
 - a. Efficiency and power factor values.
 - b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude.

- c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
 - d. Certification that all electronic circuits and printed circuit boards are conformally coated.
 10. List of recommended spare parts.
- C. Shop drawings:
 1. Complete plan and elevation drawings showing:
 - a. All dimensions.
 - b. Panel, sub-panel, and component layout indexed to the bill of material.
 - c. Conduit connections.
 - d. Required clearance around equipment.
 2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands, and the auxiliary devices.
 3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
 - a. Wiring diagrams shall include terminal number and wire numbers.
 4. Complete 1-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
 - a. Device electrical ratings shall be clearly indicated on the Drawings.
- D. Installation instructions:
 1. The written instructions must detail the complete installation of the VFD including moving, and setting into place.
 2. Provide anchorage instructions and requirements for the VFD based on the seismic requirements at the Project Site as specified in Section 16000 and other pertinent sections of the plans and specifications.:
 - a. Stamped by a Professional Engineer licensed in the state where the Project is being constructed.
- E. Harmonics:
 1. A preliminary harmonic analysis shall be performed. A power system short circuit ratio of 20 shall be used. All VFDs shall be assumed to be operating at maximum speed and maximum load. The short circuit current (ISC) utilized for the harmonic analysis calculations is defined as:
 - a. $ISC = 20 * (\text{Sum Total Full Load Amps of all VFDs})$.
 2. A separate harmonic analysis shall be performed based on the standby generator system (**as required**). Coordinate with the generator Manufacturer and the VFD manufacturer so the actual characteristics for the generator supplied, or existing, for this Project are used in the harmonic analysis.
 3. Detailed calculations or details of the actual physical testing performed on the VFD to prove the VFD is suitable for the seismic conditions at the Project Site (**as required**).

4. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. DC Link reactor shall be installed so that power fluctuations to the DC Capacitors shall be reduced to increase Capacitor life. VFDs without a DC link reactor shall provide a 5 percent impedance line side reactor and provide spare capacitors.
 - a. The VFD shall be provided with line-side harmonic reduction, as required, to insure that the current distortion limits, as defined in table 10.3 of IEEE 519-1992, are met. PCC₁, defined as the low voltage side of the distribution transformer, is used for purposes of calculation and referred, by the turns ratio of the transformer, to the PCC defined by the IEEE Recommended Practices as the Consumer-Utility interface. The tables of limits set forth therein are with reference to the PCC (primary side of the main transformer).
 - b. Harmonic solutions shall be designed to withstand up to 2 percent line imbalances with the maximum Current Distortion not to exceed 11 percent at 100 percent load.
 - c. Harmonic solutions shall be capable of withstanding up to 2 percent ambient voltage distortion with the maximum Current Distortion not to exceed 12 percent at 100 percent load.
 - d. To ascertain the harmonic contribution of the VFDs at the PCC and to show compliance with IEEE 519-1992, harmonic analysis shall be performed and submitted with the bid package, provided that the VFD vendor is in receipt of the below listed information 10 working days prior to the bid date.
 - e. kVA rating of the low voltage distribution transformer(s).
 - f. X/R Ratio of utility low voltage distribution transformer(s).
 - g. Primary voltage.
 - h. Secondary voltage.
 - i. Secondary %IZ (impedance).
 - j. Length, size, & number of conductors between transformer LV side and distribution panel.
 - k. System Single Line Diagram and electrical equipment list showing transformer and VFD detail.
 - l. Total linear load kW to be connected to the distribution transformer.
 - m. Anticipated maximum demand load (15 minute or 30 minute) on the distribution transformer (IEEE 519).
5. Harmonic Study shall be integrated with Power system study Section 16305.

F. Test reports.

1. Provide the following certified test reports for the actual VFDs being furnished:
 - a. Efficiency at 25 percent, 50 percent, 75 percent, and 100 percent speed.
 - b. Power factor at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent speed.
 - c. Certification that the actual measured harmonic distortion for both voltage and current is within the specification limits at the installed site.
 - d. Certification that the actual measured voltage at the motor terminations is less than 90 percent of the motor insulation dielectric withstand level.

G. Record documents:

1. Certified record documents of all equipment with information listed above.

- H. Manufacturer's field reports:
 - 1. Certification letter from the VFD Manufacturer that the VFD(s) has been inspected and installed in accordance with the Manufacturer's requirements.
 - 2. Report listing the setting of all VFD adjustable parameters and their values after start-up.

- I. Operation and maintenance manuals:
 - 1. Spare parts list with supplier names and part numbers.
 - 2. Start-up and commissioning instructions and data.
 - 3. Complete bill of material indexed to the drawings, identifying the catalog or part numbers, Manufacturer, and quantities of a components of the VFD system.
 - 4. Operating manuals:
 - a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
 - 5. Operating instructions:
 - a. The written descriptions shall detail the operational functions of all controls on the front panel.
 - 6. Maintenance manual:
 - a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as identifying all parts.
 - b. Manuals shall include but are not limited to the following:
 - 1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
 - 2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
 - 3) All schematic wiring and external diagrams:
 - a) Furnish drawings in a fully legible reduced 11-inch by 17-inch format.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Qualifications:
 - 1. Any third party certification, safety, or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
 - 2. VFD systems shall be UL 508C listed and labeled.
 - 3. VFDs shall be manufactured by the VFD Manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Ship VFDs to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment:
 - 1. VFDs shall be delivered to the site pre-assembled and wired.

2. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.
3. Ship each VFD with 2 non-tamperable accelerometers that record the maximum shock and vibration experienced by the VFD during shipping and handling.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.09 SEQUENCING

- A. Furnish complete submittals for review.
- B. Following approved submittal, conduct internal factory test to ensure that all systems and equipment are functional and submit certified test results for Engineer's review.
- C. Conduct factory acceptance test. The factory acceptance test shall be witnessed by Owner and/or Owner's representative at the Owner's discretion.
- D. Ship equipment to Project Site after successful completion of factory acceptance test.
- E. Install equipment in the field.
- F. Conduct field acceptance tests including harmonic testing and submit results for Engineer's review.
- G. Submit Manufacturer's certification that all equipment has been properly installed and is fully functional for Engineer's review.
- H. Conduct Owner's training sessions.
- I. Formally energize, start-up and commission equipment.

1.10 SCHEDULING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.11 WARRANTY

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Performance guaranty:
 1. Guaranty that the harmonics at the PCC, as defined herein, are at or below the levels specified.
 2. Guaranty that the power factor at the input to the VFD meets the levels as specified herein.
 3. Guaranty that the measured reflected voltage at the motor is below the motor insulation dielectric withstand level as specified herein.
 4. VFDs that fail to meet the specified harmonics, power factor or reflected

voltage criteria shall be repaired or replaced at the Owner's discretion.

5. Guaranty that the efficiency of VFD is at or greater than the levels specified.
 - a. For each VFD that fails to meet the specified efficiency, the Owner shall be reimbursed for the difference between the specified efficiency and measured efficiency at the rate of \$0.05 per kilowatt hour, for operation at 24 hours per day, 365 days per year, for 10 years.

1.12 SYSTEM START-UP

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. The VFD Manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.13 OWNERS INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING

- A. After start-up and training has been completed, the VFDs shall be commissioned by the VFD manufacturer:
 1. The VFDs shall operate the driven load without failure under normal operating conditions for a period of 30 days.
 2. Any failures shall be repaired by the VFD manufacturer. Following repair, a new 30-day period shall start.
 3. Commissioning shall only be complete once an uninterrupted 30-day period has been completed.

1.15 MAINTENANCE

- A. Maintenance service: Manufacturer shall describe the field service system available to support the proposed VFD system. As a minimum describe:
 1. Type of technical support available (e.g., system engineering and technician).
 2. Location of field service personnel.
 3. Field service daily rates in dollars per hour and dollars per day.
 4. Guaranteed response times to service requests.
- B. Spare parts:
 1. Furnish the following spare parts:
 - a. 1 set of all power and control fuses for each VFD.
 - b. 1 complete main control keypad for each type and rated size of VFD.
 - c. 1 spare fan for each VFD unit.
 - d. 2 sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
 - e. Any special dedicated tools for emergency service and troubleshooting.
 - f. Supply all hardware and software required for configuration, maintenance, troubleshooting, and inquiry of all drive parameters.
 - g. 1 complete set of power electronics for each size of VFD supplied, including rectifier assemblies, and inverter assemblies.
 - h. 1 complete set of control electronics for each size of VFD supplied, including microprocessor boards, firing boards, etc.
 - i. 1 complete set of DC link capacitors for each size of VFD supplied.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Eaton/Cutler-Hammer.
 - 2. Allen-Bradley.
 - 3. Schneider-Electric/Square D.
 - 4. General Electric.
 - 5. Siemens

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. General:
 - 1. Sinusoidal pulse width modulated (PWM) voltage source type drive shall consist of the following:
 - a. Input line reactors.
 - b. Integral phase shifting auto-transformer:
 - 1) Converts 3-phase utility power to 3 sets of 3 power circuits with each set phase shifted and powering its own 3-phase bridge rectifier.
 - c. Direct current link with capacitors.
 - d. Minimum 18-pulse diode rectifier section consisting of 3 three-phase bridge rectifiers.
 - 1) Specifically designed as a system to share currents between the bridges to within 1 percent.
 - 2) VFD designs utilizing the 6 diodes internal to the inverter and 12 diodes external to the inverter unit are not allowed.
 - e. Insulated gate bipolar transistor (IGBT), inverter section.
 - f. Microprocessor based controls.
 - g. Load reactors.
 - h. Input and output isolation contactors.
 - 2. VFDs that have an active input section for either harmonic or voltage control are not acceptable.
- B. Ratings:
 - 1. Voltage:
 - a. Input voltage: 480 Volts plus or minus 10 percent, 3-phase 60 hertz.
- C. Operational features:
 - 1. Protective features:
 - a. Include the following protective features:
 - 1) Motor overload protection.
 - 2) Instantaneous overcurrent.
 - 3) Instantaneous overvoltage.
 - 4) Undervoltage.
 - 5) Power unit overtemperature.

- 6) Phase Loss
- 7) VFD output short circuit.
- 8) VFD output ground fault.
- 9) Blown fuse.
- 10) Motor overtemperature protection:
 - a) Motor temperature switch.
 - b) Winding temperature from six 100 ohm, platinum RTDS.
 - c) Bearing temperature from two 100 ohm, platinum RTDS.
- 2. Control mode:
 - a. The VFD shall operate in either a constant volts/hertz or sensorless vector mode. The control mode selectable using the programming keypad.
- 3. Frequency control:
 - a. Minimum of 3 selectable skip frequencies with adjustable bandwidths for variable torque applications.
 - b. Programmable minimum frequency.
 - c. Programmable maximum frequency.
- 4. Acceleration/Deceleration:
 - a. Separately adjustable acceleration and deceleration rates.
 - b. Each rate shall be adjustable from 0.01 to 3,600 seconds.
- 5. Spinning load:
 - a. Capable of determining the speed and direction of a spinning load, "catch" the load and accelerate or decelerate it without damage to the load.
- 6. Programmable loss of signal:
 - a. Upon loss of reference speed signal the VFD shall be programmable to either stop, maintain current speed, or default to preselected speed.
- 7. Power interrupt ride-through:
 - a. Capable of continuous operation in the event of a power loss of 5 cycles or less.
- 8. Input/Output:
 - a. Manufacturer's standard number the following:
 - 1) Analog inputs.
 - a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
 - 2) Analog outputs.
 - a) Programmable 4 to 20 milliamperes isolated.
 - 3) Discrete inputs.
 - a) Programmable.
 - 4) Discrete outputs.
 - a) Programmable.
 - b) Form C relay contacts.
 - 5) Potentiometer 3-wire input.
 - b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.
- 9. Communications:
 - a. Provide each VFD with Ethernet/IP Communications interface module.
- 10. Automatic control:
 - a. PID capability utilizing an internal or external setpoint.
 - 1) Selectable setpoint source.
- 11. Diagnostics:
 - a. Minimum of 4 fault conditions in memory on a first-in-first-out basis.
 - b. Operating frequency, drive status and power mode shall also be stored at the time of the fault.

- c. Fault memory shall be maintained in the event of a power outage.
 - d. The fault memory shall be accessible via RS-232, RS-422 or RS-485.
12. Automatic restart:
- a. User selectable, automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
 - 1) Programmable for up to 9 automatic restart attempts with an adjustable time delay between restart attempts.

2.06 COMPONENTS

- A. Enclosure:
 - 1. NEMA Type 1 enclosure.
 - 2. Provide cooling devices required to maintain the VFD within the Manufacturer's specified temperature limits for the Project conditions:
 - a. Provide cooling device alarm.
- B. Power disconnect:
 - 1. Flange mounted thermal magnetic circuit breaker:
 - a. Lockable in the OFF position.
- C. Phase shifting transformer:
 - 1. Auto-transformer.
 - 2. Integral part of the VFD assembly and factory mounted and wired within the VFD enclosure.
 - 3. Rated for rectifier duty.
 - 4. Copper windings with 220-degree Celsius insulation.
- D. Reactors:
 - 1. Provide 3 percent output load reactors.
 - 2. Provide input line reactors.
- E. Keypad:
 - 1. Furnished with a keypad for programming and control.
 - 2. Password security to protect drive parameters.
 - 3. Mounted on the door of the VFD or motor control center.
 - 4. Back-lit LCD with a minimum of 2 lines of a minimum of 16 characters each.
 - 5. Programming and display features language: English.
 - 6. Capable of displaying the following parameters:
 - a. Speed (percent).
 - b. Output current (Amperes).
 - c. Output frequency (Hertz).
 - d. Input voltage.
 - e. Output voltage.
 - f. Total 3-phase kilowatt.
 - g. Kilowatt hour meter.
 - h. Elapsed run time meter.
 - i. Revolutions per minute.
 - j. Direct current bus voltage.
 - 7. In addition to all keys required for programming, the keypad shall have the following:
 - a. Automatic/Manual selector.
 - b. Start pushbutton.

- c. Stop pushbutton
 - d. Jog pushbutton.
 - e. Speed increment.
 - f. Speed decrement.
 - g. RUN led indicator.
 - h. PROGRAM led indicator.
 - i. FAULT led indicator.
8. Provide the VFD with the following controls:
- a. Start pushbutton.
 - b. Stop pushbutton.
 - c. Jog pushbutton.
 - d. Emergency Stop mushroom head pushbutton.
 - e. Hand/Off/Automatic selector switch.
 - f. Automatic/Manual selector switch for speed reference control.
 - g. Control Power On pilot light.
 - h. Run pilot light.
 - i. Motor Fault pilot light.
 - j. Speed potentiometer.
 - k. Elapsed time meter.
 - l. VFD/Bypass selector switch.
 - m. VFD Mode pilot light.
 - n. Bypass Mode pilot light.
 - o. Remote Start and Remote speed Control
- F. Control power transformer:
- 1. Furnish a control power transformer mounted and wired inside the drive enclosure.
 - 2. Primary and secondary fusing.
 - 3. Size the transformer to supply power to all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.
- G. VFD input contactor:
- 1. The VFD shall be provided with a contactor between the incoming power and the VFD:
 - a. The VFD shall be provided with all circuitry to control the contactor. On motor start, the VFD shall close the input contactor.
 - b. After the motor is stopped, the VFD shall open the input contactor.
- H. VFD output contactor:
- 1. The VFD shall be provided with a contactor between the VFD output and the motor:
 - a. The output contactor shall close when the VFD is energized and open on a drive fault or loss of power condition.
- I. Bypass starter:
- 1. Where indicated on the Drawings, the VFD shall be furnished with an integral reduced voltage solid state bypass starter.
 - 2. Motor overload protection for bypass operation shall be provided.
 - 3. Mechanically/electrically interlocked contactors for bypass operation shall be provided.
 - 4. A VFD/Off/Bypass selector switch shall be provided on the VFD front panel.

2.07 ACCESSORIES

- A. Metal oxide varistors:
 - 1. Provide protection for the VFD against:
 - a. Line transients: 5,000 volt peak minimum.
 - b. Line to ground transients: 7,000 peak minimum.
- B. Conformal coating:
 - 1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H₂S and chlorine.
- C. Air filters:
 - 1. Mounted on the outside of the VFD enclosure:
 - a. Replaceable without requiring that the VFD be turned off or the door opened.
 - 2. Located on the front or top of the VFD enclosure.
 - a. Side or rear mounted air filters are not acceptable.
- D. Sine wave filter:
 - 1. 3-phase, 3-wire.
 - 2. Rated for motor voltage within 10 percent.
 - 3. Full load efficiency: 99.5 percent.
 - 4. 115 degrees Celsius temperature rise.
 - 5. Open enclosure:
 - a. Mount filter in the VFD enclosure.
 - 6. Reactors: Balanced to within 3 percent of nominal value.
 - 7. Capacitors:
 - a. Temperature rated for 85 degrees Celsius.
 - b. Within 4 percent tolerance.
 - 8. Compatible with the carrier frequency range of the VFD.
 - 9. Maximum output distortion at full load and speed: 5 percent.
 - 10. Derate filter for Project altitude and temperature as specified in Section 16050.

2.08 MIXES-(NOT USED)

2.09 FABRICATION-(NOT USED)

2.10 FINISHES

- A. Enclosure finish shall be Manufacturer's standard gray color.

2.11 SOURCE QUALITY CONTROL

- A. Factory testing:
 - 1. General:
 - a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
 - b. All VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
 - c. The testing procedures specified are the minimum acceptable requirements. The Manufacturer may perform additional tests at its discretion.

2. Failure of any component during testing requires repair of the faulted component and complete retest.
3. Testing sequence:
 - a. Submit a detailed test procedure for the VFD factory test:
 - 1) A minimum of 8 weeks in advance of the proposed testing date.
 - 2) No tests shall be performed until the test procedure is reviewed and accepted by the Engineer.
4. Component tests:
 - a. Preliminary inspection:
 - 1) Verify that all components are correct.
 - 2) Verify that all connections are properly torqued.
 - b. Printed circuit boards:
 - 1) Test for correct component placement and value and complete board functional test to ensure proper performance with specified tolerances.
 - 2) Heat cycle test for 48 hours at 60 degrees Celsius.
 - 3) Apply control power to microprocessors, printed circuit boards, diagnostic boards, and similar devices including software to test for proper operation, sequencing, logic, and diagnostics.
 - 4) Test operation of all analog and discrete inputs and outputs.
 - c. Wiring:
 - 1) Control and power wiring continuity verified point-to-point.
 - 2) Hi-pot power and control wiring at manufacturer's recommended levels.
 - 3) Verify ground bond resistance.
 - d. Load testing:
 - 1) No load testing in accordance with the manufacturer's standard factory test procedure.
 - 2) Full load testing:
 - a) Test each VFD and a representative motor with the system logic and a dynamometer load to simulate field operation conditions at 25 percent, 50 percent, and 100 percent full load current.
 - b) Load test each VFD at a minimum ambient temperature of 40 degrees Celsius.
 - (1) Monitor and record temperature rise.
 - (2) Once temperature rise stops continue to operate the VFD for a minimum of 2 hours.
 - (a) If operating temperature exceeds the rated value, repair or replace the VFD and retest.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Install the VFD per the Manufacturers guidelines and submitted installation instructions to meet the seismic requirements at the Project site.

C. General:

1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete installation of the VFD (free-standing or within motor control center).
2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
3. Perform Work in accordance with the manufacturer's instructions and shop drawings.
4. Furnish components, and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install free-standing enclosures on 3-1/2-inch raised concrete housekeeping pad:
 - a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
 - b. Weld and/or bolt the VFD frame to the leveling channels.
7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
 - a. Improperly cut holes will require that the entire panel be replaced:
 - 1) No hole closers or patches will be allowed.
8. Bundle circuits together and terminate in each unit:
 - a. Tie with nylon wire ties. As specified in Section 16123.
 - b. Label all wires at each end with wire numbers shown on the approved Control Drawings.
 - c. All connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Provide the services of a VFD Manufacturer representative for start-up assistance and training:
 1. Inspection and field adjustment:
 - a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
 2. Start-up field testing:
 - a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
 - b. Under no circumstances are any portions of the drive system to be energized without authorization from the Manufacturer's representative.

- c. Compliance with the following specified parameters shall be verified by the VFD Manufacturer:
 - 1) Power factor:
 - a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.
 - b) Make measurements at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of rated speed and rated power.
 - c) Measurements shall be made with a recording type power factor meter.
 - 2) Efficiency:
 - a) Make field measurements at the input terminals of the VFD.
 - b) Make measurements at rated speed and rated power.
 - c) Make measurements with a recording type kilowatt hour meter.
 - 3) Motor terminal voltage:
 - a) Make field measurements at the motor connection box.
 - b) Make measurements of the full speed range of the VFD.
 - c) Make measurements with a recording type oscilloscope.
 - 4) Harmonics:
 - a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.
 - b) Make measurements at rated speed and rated power.
 - c) Harmonic testing shall include utility power as well as generator standby power.
 - d) Make measurements with a recording type harmonic analyzer displaying individual and total harmonic currents and voltages:
 - (1) Record currents and voltages for a minimum of 10 minutes.
 - (2) Analyzers using snapshots are not acceptable.

3.08 ADJUSTING

- A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.
- B. Provide the services of a VFD Manufacturer factory technician to make all drive parameter and protective device settings:
 - 1. Protective device settings provided by the VFD Manufacturer in accordance with the manufacturer of the driven equipment requirements.
 - 2. Provide documentation of VFD settings included but not limited to:
 - a. Minimum speed.
 - b. Maximum speed.
 - c. Skip speeds.
 - d. Current limit.
 - e. Acceleration time.
 - f. Deceleration time.
 - g. Carrier frequency.

3.09 CLEANING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

- B. Demonstrate the operation to the Engineer's and Owner's satisfaction.
- C. Training:
 - 1. Provide instruction of the Owner's operation and maintenance staff on the operation and maintenance of the VFD.
 - 2. Separate classes shall be held for the operations staff and maintenance staff:
 - a. Operations staff training shall consist of 2 identical training sessions, each consisting of 1 session per day for 2 days, with each session lasting 4 hours for a total class time of 16 hours:
 - 1) The sessions shall be scheduled with the Owner to ensure all operators have the opportunity to attend.
 - b. Maintenance staff training shall consist of 1 session per day for 2 days with each session lasting for 8 hours, for a total class time of 16 hours.
 - c. Instruction shall occur at the Owner's facility and shall utilize the actual VFDs installed at the site.

3.11 PROTECTION

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16272

DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Enclosed dry-type transformers:
 - a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
 - b. Primary voltage 600 volts and below.
- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 16000

1.02 REFERENCES

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. American National Standards Institute (ANSI):
 - 1. C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type.
 - 2. 389 – IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C57.12.01 – Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings.
 - 2. C57.12.91 – Standard Test Code for Dry-Type Distribution and Power Transformers.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. TP-1 – 2002 – Guide for Determining Energy Efficiency for Distribution Transformers.
 - 2. TP-2 – Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.
- E. Underwriters Laboratory (UL):
 - 1. 1561 – Standard for Dry-Type General Purpose and Power Transformers.

1.03 DEFINITIONS

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.04 SYSTEM DESCRIPTIONS

- A. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
 - 1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 16050 after all derating factors have been applied.
 - 2. Suitable for continuous operation at full rating with normal life expectancy in accordance with ANSI C57.96.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Product data:
 - 1. Catalog cut sheets.
 - 2. Nameplate data.
 - 3. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 - 4. Inrush current.
 - 5. Insulation system and temperature constraints.
 - 6. Number and rating of taps.
 - 7. Sound levels.
 - 8. Connection diagrams:
 - a. Primary.
 - b. Secondary.
 - 9. BIL rating.
 - 10. Required clearances.
 - 11. Percent impedance.
 - 12. Efficiency.
 - 13. Certification of low temperature rise design.
 - 14. Certification of full capacity capability at the Project elevation and ambient conditions.
 - 15. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
- C. Installation instructions:
 - 1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
 - 2. For equipment installed in structures designated as seismic design category A or B:
 - a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.

3. For equipment installed in structures designated as seismic design category C, D, E, or F:
 - a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
 - b. Submit anchoring drawings with supporting calculations.
 - c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 1. General Electric.
 2. Schneider Electric/Square D.
 3. Eaton/Cutler-Hammer.

4. ABB.
5. Siemens.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Cores:
 1. Non-aging, grain-oriented silicon steel.
 2. Magnetic flux densities below the saturation point.
- B. Windings:
 1. High-grade magnet wire.
 2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
 - a. Cured to reduce hot-spots and seal out moisture.
 3. Material electrical grade:
 - a. Copper.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. General:
 1. 10 kilovolts BIL for 600-volt class windings.
 2. Sound levels, in accordance with ANSI 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (db)
1-9	40
10-50	45
51-150	50
151-300	55
301-500	60
501-700	62
701-1000	64

3. Taps:
 - a. 15 kilovolt-amperes and less:
 - 1) Two 5 percent full capacity primary taps below rated voltage.
 - b. 25 kilovolt-amperes and larger:
 - 1) Four 2.5 percent full capacity primary taps below rated voltage.
 - 2) Two 2.5 percent full capacity primary taps above rated voltage.
 - c. Operated by a tap changer handle or tap jumpers accessible through a panel.
 4. Terminals:
 - a. UL listed for either copper or aluminum conductors.
 - b. Rated for 75 degrees Celsius.
 5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with ANSI C57.96.
- B. Transformers less than 15 kilovolt-amperes:
 1. Insulation class: 185 degrees Celsius.
 2. Temperature rise: 115 degrees Celsius.

- C. Energy efficient transformers 15 kilovolt-amperes and larger:
 - 1. Insulation class: 220 degrees Celsius.
 - 2. Temperature rise: 115 degrees Celsius, except as noted below:
 - a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
 - 3. Efficiency:
 - a. In accordance with NEMA TP-1.
 - b. Measured in accordance with NEMA TP-2.

- D. Low temperature rise transformers 15 kilovolt-amperes and larger:
 - 1. Insulation class: 220 degrees Celsius.
 - 2. Temperature rise: 115 degrees Celsius.
 - 3. Efficiency:
 - a. Minimum of 96 percent for 115 degree rise.

- E. K-factor transformers:
 - 1. Provide K-factor transformers with ratings as indicated on the Drawings.
 - 2. Insulation class: 220 degrees Celsius.
 - 3. Temperature rise: 115 degrees Celsius.
 - 4. Neutral bus sized for 200 percent of rated current.
 - 5. Electrostatic shielding between the primary and secondary windings.

- F. Enclosures:
 - 1. Heavy gauge steel:
 - a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
 - b. Indoor: NEMA Type 1.
 - 2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
 - 3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
 - a. Neoprene vibration pads and sleeves.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Nameplates:
 - 1. Non-corrosive metal or UL listed non-metallic:
 - a. Stamped, engraved or printed with the following information:
 - 1) Phases.
 - 2) Frequency.
 - 3) Kilovolt-ampere rating.
 - 4) Voltage ratings.
 - 5) Temperature rise.
 - 6) Impedance.
 - 7) Insulation class.
 - 8) BIL rating.
 - 9) Connection diagram.
 - 10) Weight.
 - 11) Manufacturer.
 - 12) The identification "transformer."
 - 13) Classes of cooling.

- 14) Tap voltage(s).
- 15) Vector diagram.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer's standard gray enamel rust-inhibiting paint.

2.11 SOURCE QUALITY CONTROL

- A. Factory tests:
 1. Applied voltage test to each winding and from each winding to the core:
 - a. 600-volt class winding 4.5 kilovolt.
 2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
 3. Voltage ratio and polarity.
 4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.
 5. Perform all tests in accordance with UL 1561.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. General:
 1. Floor, wall, platform, motor control center, packaged power supply, or roof mounted, as indicated on the Drawings.
 2. Locate where not in direct contact with building structure.
 3. Install on double-deflection mounts selected for maximum isolation manufactured by Korfund or equal.
 4. Make any necessary connections to the enclosure with liquidtight, flexible conduit having neoprene gaskets and insulated ground bushings.
 5. Ground the enclosure:
 - a. To an equipment ground conductor in the conduit.
 - b. To the facility grounding electrode system.

6. Floor mounted transformers:
 - a. Install transformers on 3-1/2-inch housekeeping pads.
 - b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer's recommendations.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

3.08 ADJUSTING

- A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

3.09 CLEANING

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16285

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. High-energy surge protective devices.
- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Section 16000 – Common Work Results for Electrical.

1.02 REFERENCES

- A. As specified in Section 16000.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 2. C62.45 – Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
 - 3. C62.62- Standard Test Specifications for Surge Protective Devices for Low-Voltage AC Power Circuits.
- C. Underwriters Laboratory:
 - 1. 1449, 3rd Edition, Standard for Surge Protective Devices.

1.03 DEFINITIONS

- A. As specified in Section 16000.
- B. Specific definitions:
 - 1. SPD: Surge protective device.
 - 2. SAD: Silicon avalanche diode.
 - 3. MOV: Metal oxide varistor.
 - 4. MCOV: Maximum continuous operating voltage.
 - 5. I_n : Nominal discharge current.
 - 6. VPR: Voltage protection rating.

7. SCCR: Short circuit current rating.

1.04 SYSTEM DESCRIPTION

- A. Surge protective devices as an integral component of the electrical equipment.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of plans and specifications.

- B. Product data:

1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
2. Manufacturer's catalog cut sheets indicating:
 - a. Manufacturer and model numbers.
 - b. Ratings of each SPD including but not limited to:
 - 1) Short circuit current rating.
 - 2) Nominal discharge current.
 - 3) Maximum continuous operating voltage.
 - 4) Voltage protection rating.
 - 5) System voltage.
 - 6) System frequency.
 - 7) Surge current capacity.
3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
 - a. Overcurrent protection.
 - b. UL 1449.

- C. Shop drawings:

1. Provide electrical and mechanical drawings by the manufacturer that detail:
 - a. Unit dimensions.
 - b. Weights.
 - c. Components.
 - d. Field connection locations.
 - e. Mounting provisions.
 - f. Connection details.
 - g. Wiring diagram.

- D. Operation and maintenance manuals:

1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of plans and specifications.

- B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:

1. Institute of Electrical and Electronics Engineers (IEEE C62.41, C62.45, C62.62).
2. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
3. National Electrical Manufacturer Association.
4. National Fire Protection Association (NFPA 20, 75 and 780).

5. National Electric Code (NFPA 70).
6. Underwriters Laboratories (UL 1449 3rd Edition and UL 1283).
7. International Electrotechnical Commission (IEC 801).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16000 and other pertinent sections of plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16000 and other pertinent sections of plans and specifications.

1.09 SEQUENCING

- A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 16000 and other pertinent sections of plans and specifications.
- B. Extended warranty:
 1. Furnish a manufacturer's full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
 2. Warranty shall include:
 - a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
 - b. A 24-hour toll-free 800-number for warranty support.

1.12 SYSTEM START-UP

- A. As specified in Section 16000 and other pertinent sections of plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 1. Liebert.
 2. Eaton/Cutler-Hammer.
 3. Schneider Electric/Square D.
 4. General Electric.

5. Siemens.
6. Current Technology.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Provide units as required for the locations indicated on the Drawings.
- B. Electrical requirements:
 1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
 2. MCOV:
 - a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
 3. Operating frequency:
 - a. 47 to 63 hertz.
 4. SCCR:
 - a. 100 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
 - b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
 5. Nominal discharge current I_n :
 - a. 20 kA.
 6. Maximum VPR:

Modes	240/120	208Y/120	480Y/277
L-N, L-G, N-G	900	900	1,500
L-L	1,800	1,200	2000

7. Peak surge current:
 - a. Service entrance switchboard locations:
 - 1) 300 kA per phase minimum.
 - 2) 120 kA per mode minimum.
 - b. Switchboards and IMCC (Intelligent Motor Control Centers)
 - 1) 200kA per phase minimum switchboard.
 - c. Panel locations:
 - 1) 150 kA per phase, minimum.
 - 2) 60 kA per mode minimum.
- C. Protection modes:
 1. Provide SPD protection modes as follows:
 - a. Line to Neutral (L-N) where applicable.
 - b. Line to Ground (L-G).
 - c. Neutral to Ground (N-G), where applicable.
 - d. Directly connected MOV(L-L), where applicable.

- D. Environmental requirements:
 - 1. Storage temperature:
 - a. -40 degrees to +50 degrees Celsius.
 - 2. Operating temperature:
 - a. -0 degrees to +60 Celsius.
 - 3. Relative humidity:
 - a. 5 percent to 95 percent.
 - 4. Audible noise:
 - a. Less than 45 dBa at 5 feet (1.5 m).
 - 5. Operating altitude:
 - a. Zero to 12,000 feet above sea level.
- E. Provide surge protective devices that are suitable for application in IEEE C62.41. Entrance as tested to IEEE C62.45.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

- A. Enclosure:
 - 1. Located in electrical equipment as indicated on the Drawings.
 - 2. External mounting:
 - a. NEMA Type 12 enclosure:
 - 1) No ventilation openings.
 - b. Hinged cover requiring a tool for internal access.
 - c. Internal drawing pocket.
 - d. All monitoring indications must be visible without opening the door.
- B. Internal connections:
 - 1. Provide low impedance copper plates for intra-unit connections:
 - a. Attach surge modules using bolted connections to the plates for low-impedance connections.
 - 2. Size all connections, conductors, and terminals for the specified surge current capacity.
- C. Surge diversion modules:
 - 1. MOV:
 - a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.
- D. Overcurrent protection:
 - 1. Individually fuse all components, including suppression, filtering, and monitoring components:
 - a. Rated to allow maximum specified nominal discharge current capacity.
 - b. Overcurrent protection that limits specified surge currents is not acceptable.
- E. Connections:
 - 1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.07 ACCESSORIES

- A. Unit status indicators:
 - 1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
 - a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
 - b. Indicates the status of protection on each mode or phase.
- B. Dry contacts for remote monitoring:
 - 1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.
- C. Provide an audible alarm which activates under any fault condition.
 - 1. Provide an alarm On/Off switch to silence the alarm.
 - 2. A visible LED will confirm whether alarm is On or Disabled.
 - 3. Locate both switches and the audible alarm on the unit's front cover.
- D. Provide transient counter to count transient voltage surges:
 - 1. LCD readout located on the unit's front cover.
 - 2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.
 - 3. If a dedicated breaker for the SPD is not provided in the switchboard, the service entrance SPD shall include an integral UL listed disconnect switch. A dedicated breaker shall serve as means of disconnecting for distribution SPDS.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Permanently affix surge rating to the SPD.
- B. Perform Manufacturer's standard factory test.
 - 1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16000 and other pertinent sections of the plans and specifications.
- B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

- C. Special techniques:
 - 1. Install the SPD with as short and straight conductors including ground conductor as practically possible:
 - a. Twist the input conductors together to reduce input conductor inductance.
 - 2. Interconnect the SPD to the power system using a Manufacturer-supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.
 - 3. Do not subject SPD to insulation resistance testing.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16950.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16411
DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Fusible and non-fusible disconnect switches.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Submittal Procedures.
 - b. Commissioning and Process Start-up.
 - c. Section 16000 - Common Work Results for Electrical.
 - d. Section 16075 - Identification for Electrical Systems.
 - e. Section 16305 - Electrical System Studies.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. Underwriters Laboratories Inc. (UL):
 - 1. 20 - General-Use Snap Switches.
 - 2. 98 - Enclosed and Dead-Front Switches.
 - 3. 508 - Standard for Industrial Control Equipment.

- C. National Electric Manufacturer's Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment.
 - 2. KS 1-2001- Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.03 DEFINITIONS

- A. As specified in Section 16000.

- B. Specific definitions:
 - 1. Safety switches and disconnect switches are to be considered synonymous.

1.04 SYSTEM DESCRIPTION

- A. Provide heavy-duty type disconnect switches as indicated on the Drawings and specified in the Contract Documents.
- B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 16000 and other pertinent sections of the plans and specifications.
- B. Product data:
 - 1. Manufacturer.
 - 2. Manufacturer's specifications and description.
 - 3. Ratings:
 - a. Voltage.
 - b. Current.
 - c. Horsepower.
 - d. Short circuit rating.
 - 4. Fused or non-fused.
 - 5. NEMA enclosure type.
 - 6. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 - 7. Weight.
 - 8. Cross-referenced to the disconnect schedule indicated on the Drawings.
- C. Shop drawings:
 - 1. Manufacturer's installation instructions:
 - a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
 - b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
 - 2. Identify motor or equipment served by each switch; indicate nameplate inscription.
- D. Installation instructions:
 - 1. Provide anchorage instructions and requirement based on the seismic requirements at the Project Site as specified in Section 16050 and calculations:
 - a. Stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.
- B. Regulatory requirements:
 - 1. NEMA KS1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).

2. UL 98 - Enclosed and Dead-Front Switches.

C. Disconnect switches shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16305 and submit results for Engineer's review.

B. After successful review of the initial fault current study, submit complete equipment submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

B.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
1. Schneider Electric/Square D Company.
 2. Eaton/Cutler-Hammer.
 3. General Electric.
 4. Siemens.
 5. Appleton.
 6. Crouse-Hinds.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. Switch mechanism:
 - 1. Quick-make, quick-break heavy-duty operating mechanisms:
 - a. Provisions for padlocking the switch in the Off position.
 - b. A minimum of 90-degree handle travel position between Off and On positions:
 - 1) Provide handle position indicators to identify the handle position.
 - c. Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
 - 1) With an externally operated override.
- B. Switch interior:
 - 1. Switch blades visible when the switch is Off and the cover is open.
 - 2. Lugs:
 - a. Front accessible.
 - b. Removable.
 - c. UL listed for 60/75-degree Celsius copper conductors.
 - 3. Current carrying parts completely plated to resist corrosion.
 - 4. Removable arc suppressors to facilitate easy access to line side lugs.
 - 5. Furnish equipment ground kits for every switch.
- C. Fused switches:
 - 1. Furnish with fuses as indicated on the Drawings:
 - a. Provide fuses as specified in Section 16494.
 - 2. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
 - a. Ratings 100 amperes through 600 amperes at 240 volts.
 - b. Ratings 30 amperes through 600 amperes at 600 volts. c. Provide spring reinforced and plated fuse clips.
- D. Ratings:
 - 1. UL horsepower rated for AC or DC with the rating not less than the load served.
 - 2. Current:
 - a. 30 to 1,200 amperes.
 - 3. Voltage:
 - a. 250 volts AC, DC.
 - b. 600 volts (30 A to 200 A, 600 volts DC).
 - 4. Poles:
 - a. 2, 3, 4, and 6 poles.
 - 5. UL listed short circuit ratings:
 - a. 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes).
 - b. 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 amperes employing appropriate fuse rejection).
 - c. 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1,200 amperes).
 - 6. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 16050 for the installed location.

- E. Size, fusing and number poles as indicated on the Drawings or as required:
 - 1. Provide solid neutral where indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Disconnect switches to have provisions for a field installable "B" type electrical interlock for position indication as indicated on the Drawings.
- B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.
- C. NEMA Type 7 and 9 enclosures furnished with drain and breather kit when used in outdoor applications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. General:
 - 1. Use Myers hubs or bolt-on hubs for all conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
 - 2. Provide all mounting brackets, stands, supports and hardware as required:
 - a. Match finish and materials for all brackets, stands, and hardware with the switch installed.
 - b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
 - 3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
 - a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.

- b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
- 4. Provide a nameplate for each disconnect switch:
 - a. Provide per requirements specified in Section 16075.
 - b. Identify voltage, circuit, fuse size, and equipment served on the nameplate.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

- A. As specified in pertinent Sections

3.08 FIELD QUALITY CONTROL

- A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

- A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

3.11 PROTECTION

- A. As specified in Sections 16000 and other pertinent sections of the plans and specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16444

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Low voltage intelligent motor control centers.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 01330 – Submittal Procedures.
 - b. Section 16000 – Common Work Results for Electrical.
 - c. Section 16075 – Electrical Identification.
 - d. Section 16123 – 600 Volt or Less Wires and Cables.
 - e. Section 16150 – Low Voltage Wire Connections.
 - f. Section 16262 – Variable Frequency Drives 0.50 – 50 Horsepower.
 - g. Section 16264 – Variable Frequency Drives 60-500 Horsepower.
 - h. Section 16272 – Dry Type Transformers.
 - i. Section 16281 – Harmonic Filters.
 - j. Section 16285 – Surge Protective Devices.
 - k. Section 16305 – Electrical System Studies.
 - l. Section 16412 – Low Voltage Molded Case Circuit Breakers.
 - m. Section 16422 – Motor Starters.
 - n. Section 16445 – Panelboards.
 - o. Section 16494 – Low Voltage Fuses.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. National Electrical Manufacturer's Association (NEMA):
 - 1. ICS 18-2001 – Motor Control Centers.
 - 2. ICS 2-322.
 - 3. ICS 1-2001– Industrial Control and Systems: General Requirements.

- C. Underwriters Laboratories (UL):
 - 1. 845 – Motor Control Centers.
 - 2. 489 – Molder Case Circuit Breakers.

1.03 DEFINITIONS

- A. As specified in Section 16000.
- B. Intelligent Motor Control Center- Motor Control Center incorporating motor control, protection, power monitoring, communication and automation interfacing for each motor management device.

1.04 SYSTEM DESCRIPTION

- A. Factory assembled, factory wired and factory tested intelligent motor control centers:
 - 1. Motor control centers and major components to be products of a single manufacturer including, but not limited:
 - a. Starters.
 - b. VFD.
 - c. RVSS.
 - d. Power Management Devices.
 - e. IMCC PLC.
 - f. Human Machine Interface Panel (HMI).
 - g. Network Gateway.
 - h. Power Supplies.
 - i. Surge Protection Devices (SPDs).
 - j. Pilot Lights, Selector Switches, Relays, and Accessories.
 - k. Active harmonic filters for 6-pulse variable frequency drives, as referred in spec section 16281.
 - l. Related equipment specified in the Contract Documents or indicated on the Drawings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Product data:
 - 1. Manufacturer of motor control center.
 - 2. Manufacturer of motor control center parts.
 - 3. Nameplate schedule.
 - 4. Bill of material.
 - 5. Enclosure:
 - a. NEMA rating.
 - b. Finish color.
 - 6. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Current:
 - 1) Horizontal bus ampacity.
 - 2) Vertical bus ampacity.
 - 3) Ground bus ampacity.
 - d. Short circuit withstand rating.
 - e. Protective device interrupting rating.
 - 7. List of recommended spare parts.

8. Catalog cut sheets:
 - a. Submit complete Manufacturer's catalog information:
 - 1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
 9. Furnish circuit breaker submittals as specified in Section 16412. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16000:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
 - b. Manufacturer's special seismic certification with substantiating test data.
 10. Motor Management Device product data.
 11. Internal communication media and communicating protocol.
 12. Network interface gateway devices.
 13. Power supply product data.
 14. Surge Protection Devices.
- C. Shop drawings:
1. Layout drawings:
 - a. Provide fully dimensioned and to scale layout drawings which include:
 - 1) Dimensions:
 - a) Overall length.
 - b) Overall width.
 - c) Overall height.
 - d) Overall weight and weight of individual shipping splits.
 2. Interfaces to other equipment.
 3. Shipping splits.
 4. Allowable top and bottom conduit windows.
 5. Complete component and unit layout drawings.
 6. Indicate lug sizes, type, and Manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
 7. Elementary schematics:
 - a. Provide one custom schematic diagram for each compartment:
 - 1) Include all remote devices.
 - 2) Show wire numbers on the schematics:
 - a) Provide wire numbering as specified in Section 16075.
 8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
 9. One-line diagrams:
 - a. Provide complete one-line diagrams for each motor control center, including but not limited to: protective devices, starters, drives, metering, and other equipment.
 - b. Indicate electrical ratings of the equipment shown on the one-line diagrams.
- D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
 2. For equipment installed in structures designated as seismic design category A or B:
 - a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.

3. For equipment installed in structures designated as seismic design category C, D, E, or F:
 - a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
 - b. Submit anchoring drawings with supporting calculations.
 - c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

- E. Operation and maintenance manuals:
 1. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
 - a. Electrical ratings:
 - 1) Phase.
 - 2) Wire.
 - 3) Voltage.
 - 4) Ampacity.
 - 5) Bus bracing and protective device interrupting ratings.
 - b. Manufacturer's operating and maintenance instructions for the motor control center and all component parts, including:
 - 1) Starters.
 - 2) Overload relays and heater elements.
 - 3) Variable frequency drives.
 - 4) Protective devices including, but not limited to, fuses, circuit breakers, and protective relays.
 - 5) Pilot devices.
 - c. Complete renewal parts list.

- F. Record Documents:
 1. Elementary schematics:
 - a. Furnish as-built elementary schematics indicating final:
 - 1) Wire numbers.
 - 2) Interfaces with other equipment.
 - b. Provide one custom schematic diagram for each compartment:
 - 1) Include all remote devices.
 - 2) Show wire numbers on the schematics.
 - c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
 2. The Record Documents shall reflect all modifications made during the submittal review process and during construction.

- G. Calculations:
 1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project site.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

- B. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.

1.07 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.09 SEQUENCING

- A. Conduct the initial fault current study as specified in Section 16305 and submit results for Engineer's review.
- B. After successful review of the initial fault current study, as specified in Section 16305, submit complete equipment submittal as specified in the Submittals article of this Section for Engineer's review.
- C. Conduct internal factory test to ensure that systems and equipment are functional and submit certified test results for Engineer's review.
- D. Assemble equipment in the field.
- E. Conduct field acceptance test and submit results for Engineer's review.
- F. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.
- G. Conduct Owner's training sessions.
- H. Formally energize, start-up and commission equipment.

1.10 SCHEDULING

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.11 WARRANTY

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.12 SYSTEM START-UP

- A. Provide with onsite services as specified in section 01756.

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with performance and dimensional criteria, approved manufactures shall be one of the following or equal:
1. Allen-Bradley.
 2. Eaton/Cutler-Hammer.
 3. Schneider Electric/Square D.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. General:
1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
 2. Arrange the equipped sections side by side and/or back-to-back to form continuous motor control center lineups as indicated on the Drawings:
 - a. Identify any deviations from the Drawings in writing and submit for approval.
 3. Provide wire markers at each end of every wire as specified in Section 16075.
 4. Provide complete and functional motor control centers.
 5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.
 6. Provide new components of the latest construction series available from the manufacturer.
- B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.
- C. Bus system:
1. Material:
 - a. Tin-plated copper.
 - b. Short-circuit rating:
 - 1) All power bus shall be braced to withstand a fault current equal to or greater than the AIC rating indicated on the Drawings.
 - c. Bus bar supports:
 - 1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
 2. Horizontal power bus:
 - a. Fully sized to carry 100% of the rated current indicated on the drawings the entire length of the iMCC. Tapered horizontal bus not acceptable.

- b. Mounting:
 - 1) Mount horizontal bus bars edgewise at the top of the MCC, one above the other, and fully isolated from all wireways and units.
- c. Temperature rise:
 - 1) In accordance with UL 845.
 - 2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 16050.
- 3. Vertical power bus:
 - a. Current-carrying capacity of not less than 300 amps.
 - b. Mounting:
 - 1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
 - a) Provide automatic shutter mechanism to cover the stab openings when plug-in units are removed. Unused stab openings shall be provided with automatic shutter mechanisms.
 - 2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
 - c. Isolated from the unit compartments by a full-height barrier.
- 4. Neutral bus:
 - a. Provided in 4-wire motor control centers as indicated on the Drawings.
 - b. Current carrying capacity of 100 percent of horizontal power bus.
 - c. Mounting:
 - 1) Bus shall extend the full width of the motor control center.
 - d. Pre-drilled and furnished with lugs for attachment of neutral conductors:
 - 1) Furnish a minimum of 50 percent spare lugs in each vertical section of motor control center.
- 5. Ground bus:
 - a. Horizontal ground bus:
 - 1) Current-carrying capacity of not less than 600 amps.
 - 2) Mounting:
 - a) Full-width, firmly secured to each vertical section structure:
 - (1) Located in the top or bottom wireway.
 - b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
 - (1) Furnish a minimum of 10 lugs per vertical section of MCC.
 - b. Vertical ground bus.
 - 1) Mounting:
 - a) Furnish in each vertical section.
 - b) Bolted to the horizontal ground bus.
 - c) Install parallel to the vertical power bus.
 - d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.
 - e) Ground bus shall be equipped with load terminals.
- 6. Bus splice bars:
 - a. Provided to join the bus at the splits.
 - b. Connected to each horizontal bus bar with a minimum of two bolts.
 - c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
 - d. Same ampacity rating as the horizontal bus.
 - e. Connecting hardware shall be designed to be tightened from the front of

- the iMCC without applying any tools to the rear of the connection.
7. Provide bus system configured for back-to-back MCCs, where required.
- D. Enclosures:
1. Each motor control center shall consist of 1 or more vertical sections bolted together:
 - a. Freestanding.
 - b. Totally enclosed.
 - c. Dead-front assembly.
 - d. Designed for modification and/or addition of future vertical sections.
 - e. Form each vertical section of heavy gauge steel.
 - f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
 2. Enclosure rating:
 - a. Indoor:
 - 1) NEMA Type 1 with gasketed doors.
 3. Standard section dimensions:
 - a. Nominal height: 90 inches.
 - b. Nominal depth: 20 inches.
 - c. Vertical section width as indicated on the Drawings.
 4. Wireways:
 - a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
 - 1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
 - b. Provide each vertical section with a full-height vertical wireway. The rear surface of the wireway shall be painted white.
 - c. Completely isolated from the vertical and horizontal bus bars.
 - d. Provide a removable, hinged door.
 5. Shipping splits:
 - a. No more than 3 vertical sections and not more than 60 inches in width.
 - b. Solid bussing between vertical sections in a shipping split is not acceptable.
 6. Lifting angles:
 - a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
 - 1) Extending the entire width of the shipping split.
 7. Mounting channels:
 - a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.
- E. Units:
1. A plug-in unit consists of:
 - a. Unit assembly.
 - b. Unit support rails.
 - c. Unit door assembly.
 2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
 3. Constructed so that any fault will be contained in the unit compartment.
 4. Supported and guided by a removable unit support pan:
 - a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
 5. Held in place by screws or other positive locking means after insertion.

6. Provide a test position with the unit supported in the structure but disengaged from the bus.
7. Integral plug-in ground stab.
8. Stabs:
 - a. Free floating.
 - b. Self-aligning.
 - c. Backed by spring steel clips to ensure high pressure contacts:
 - d. Electrolytically tin-plated copper.
9. Handle:
 - a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
 - b. Door mounted operators or operator handles are not acceptable.
 - c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
 - d. Lockable in the "OFF" position with up to 3 padlocks.
 - e. Mechanically interlocked so that the door cannot be opened with the handle in the "ON" position.
 - 1) Provide a means for qualified personnel to defeat this interlock.
 - f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the "ON" position.
 - g. Lockable in the "ON" position:
 - 1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
 - h. Color-coded to indicate position.
 - i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
10. Where indicated on the Drawings, provide units for spaces and future equipment:
 - a. Equip these units to accept a future plug-in unit without modification to the vertical sections.
11. Pilot device contacts shall be rated at 10A, 600VAC (NEMA A600).
12. Unit identification nameplate shall be provided for each unit in accordance with Section 16075 on the front of the unit.

F. Communication equipment:

1. Furnish motor control centers with a factory installed Ethernet/IP communications network.
2. Provide internal gateways, Ethernet switches (Non-managed), and repeaters as required.
3. The Ethernet/IP network shall include a complete and tested cabling system compliant with and approved by the ODVA (Open Device Vendors Association) Ethernet/IP Standard.
4. Ethernet/IP network:
 - a. CAT6E cable.
5. Accessories:
 - a. Provide the motor control center with a 24 volt DC power supply to provide power to all communication devices in the motor control center:
 - 1) Installed in a motor control center compartment.
 - 2) Furnished with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/from other power supplies on the network.

- 3) Capable of communicating on the EtherNet/IP network and act as one node on the Ethernet/IP network.
- b. Furnish 2 male and 2 female terminating resistors.
6. Harmonics:
 - 1) A harmonic distortion analysis shall be performed and priced as a separate line item by the AC Drive manufacturer based upon system documentation supplied by the contractor. The documentation shall consist of one-line diagrams, distribution transformer information (kVA, %Z, and X/R ration) and emergency standby generator performance specifications. The harmonic distortion analysis report shall be part of the approval drawing process, submitted to the engineer for approval. If the calculations determine that harmonic distortion values are higher than the voltage and current values specified in IEEE 519-1992, the drive manufacturer shall provide line reactors of sufficient percent impedance to meet the IEEE specified values. The line reactor shall be ventilated in the iMCC and shall be completely factory wired and tested with the AC Drive controller unit. Coordinate and report with Section 16305 and 16264.

2.06 COMPONENTS

- A. Provide components contained within the motor control center as specified in:
 1. Section 16075.
 2. Section 16123.
 3. Section 16150.
 4. Section 16262.
 5. Section 16272.
 6. Section 16285.
 7. Section 16412.
 8. Section 16422.
 9. Section 16445.
 10. Section 16494.
 11. Section 17710.

2.07 ACCESSORIES

- A. Wiring:
 1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
 - a. NEMA Class II-S:
 - 1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
 - 2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e. electrical interlocking, etc.
 - 3) Provide custom drawings with unique terminal numbering designations in lieu of standard Manufacturer drawings.
 - b. NEMA Type B wiring:
 - 1) Control wiring:
 - a) Type B-T pull-apart terminal blocks.
 - 2) Power wiring:
 - a) Type B-T for Size 1 starters.
 - b) Type B-T or B-D for Size 2 and 3 starters.
 - c) Type B for Size 4 and larger starters and feeder units.

- B. Lugs and terminals:
 - 1. For all external connections of No. 6 AWG wire or larger:
 - a. UL listed for copper or aluminum conductors.
 - 2. Compression type, requiring a hydraulic press and die for installation.
 - 3. Provide 20 percent spare control block terminals.

- C. Nameplates:
 - 1. Provide nameplates as specified in Section 16075:
 - a. Identifying the motor control center designation as indicated on the Drawings.
 - 2. Identifying each vertical section:
 - a. Mounted and centered on the top horizontal wireway of the vertical section.
 - 3. Furnish individual nameplates for each unit indicated on the Drawings:
 - a. 1 nameplate to identify the unit designation.
 - b. 1 nameplate to identify the load served.
 - c. Furnish space units with blank nameplates.
 - 4. Manufacturer's labels:
 - a. Furnish each vertical section with a label identifying:
 - 1) Serial number.
 - 2) Bus rating.
 - 3) Vertical section reference number.
 - 4) Date of manufacture.
 - 5) Catalog number of section.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

- B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16050.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. General:
 - 1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories necessary to completely install the motor control center for the line, load, and control connections.
 - 2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
 - 3. Make bus splice connections.
 - 4. Perform work in accordance with manufacturer's instruction and shop drawings.
 - 5. Furnish all components, and equipment necessary to complete the installation.
 - 6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
 - 7. Install the iMCC on a 3-1/2-inch raised concrete housekeeping pad:
 - a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
 - 1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
 - b. Weld and/or bolt the motor control center frame to leveling channels.
- D. Provide openings in the top or bottom of the motor control center for conduit only.
 - 1. No additional openings will be accepted:
 - a. Mis-cut holes will require that the entire vertical section or removable panel be replaced.
 - b. No hole closers or patches will be accepted.
- E. Bundle circuits together and terminate in each unit:
 - 1. Tie with nylon wire ties as specified in Section 16123.
 - 2. Label all wires at each end with wire markers as specified in Section 16075 as shown on the approved elementary schematics.

3.04 ERECTION, INSTALLATION, APPLICATION CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16050.
- B. Provide the services of a manufacturer's representative to:
 - 1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.08 ADJUSTING

- A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.09 CLEANING

- A. As specified in Section 16050.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 16050.
- B. Demonstrate the operation of the motor control center to the Engineer's and Owner's satisfaction.
- C. Training:
 - 1. Provide training for motor control center components as specified in the individual component specifications.

3.11 PROTECTION

- A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16600

ELECTRICAL ACCEPTANCE TESTING

PART 1 GENERAL

1.01 SCOPE:

A Perform acceptance testing of electrical apparatus and circuits described herein to determine suitability for energization and operation. It is the intent of these specifications to assure that the completed electrical installation is installed in accordance with the design drawings and specifications and is operational with industry and manufacturer's tolerance.

B. Provide all material, equipment, labor and technical supervision to perform tests and inspections as described herein.

1.02 REFERENCES:

A All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.

1. American National Standards Institute- ANSI

2. American Society for Testing and Materials- ASTM

ASTM 877. Test Method for Dielectric Breakdown Voltage of Insulating Liquids using Disk Electrodes.

ASTM D 923. Test Method for Sampling Electrical Insulating Liquids.

ASTM D 971. Test Method for Interfacial Tension of Oil Against Water by the Ring Method.

ASTM D 974. Test Method for Acid and Base Number by Co/or-Indicator Titration.

ASTM D 1500. Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).

ASTM D 1524. Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.

ASTM D 1533. Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method).

ASTM D 1816. Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.

3. Institute of Electrical and Electronic Engineers-IEEE ANSI/IEEE C2, *National Electrical Safety Code*

ANSI/IEEE C37, *Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses.*

ANSI/IEEE C57, *Distribution, Power and Regulating Transformers.*

ANSI/IEEE C62, *Surge Protection*

ANSI/IEEE Std. 43. *IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.*

ANSI/IEEE Std. 48. *IEEE Standard Test Procedures and Requirements for High-Voltage AC Cable Terminations*

ANSI/IEEE Std. 81. *IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.*

ANSI/IEEE Std. 95. *IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.*

ANSI/IEEE Std. 141. *IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (IEEE Red Book).*

ANSI/IEEE Std. 142. *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).*

ANSI/IEEE Std. 241. *IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).*

ANSI/IEEE Std. 242. *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).*

ANSI/IEEE Std. 399. *IEEE Recommended Practice for Power Systems Analysis (Brown Book).*

ANSI/IEEE Std. 400. *IEEE Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.*

ANSI/IEEE Std. 421B. *IEEE Standard for High-Potential-Test Requirements for Excitation Systems for Synchronous Machines.*

ANSI/IEEE Std. 446. *IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book).*

ANSI/IEEE Std. 450. *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.*

ANSI/IEEE Std. 493. *IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book).*

ANSI/IEEE Std. 602. *IEEE Recommended Practice for Electric Systems in Health Care Facilities (White Book).*

ANSI/IEEE Std. 637. *IEEE Guide for the Reclamation of Insulating Oil and Criteria for its use.*

ANSI/IEEE Std. 739. *IEEE Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities (Orange Book).*

ANSI/IEEE Std. 1100. *IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).*

ANSI/IEEE Std. 1106. *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations.*

4. Insulated Cable Engineers Association – ICEA

5. InterNational Electrical Testing Association-NETA

Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

6. National Electrical Manufacturer's Association-NEMA

NEMA Standard for Publication No. AB4: *Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications.*

NEMA Publication MG1: *Motors and Generators*

7. National Fire Protection Association- NFPA ANSI/NFPA 70: *National Electrical Code.* ANSI/NFPA 708: *Recommended Practice for Electric Equipment Maintenance.* ANSI/NFPA 70E: *Electrical Safety Requirements for Employee Workplaces.* ANSI/NFPA 780: *Lightning Protection Code.*

8. Occupational Safety and Health Administration-OSHA

9. State and local codes and ordinances

10. Underwriters Laboratory- UL

1.03 QUALIFICATIONS OF TESTING FIRM:

A. The testing firm shall be a independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person shall be currently certified by the International Electrical Testing Association (NETA) or the National Institute for

Certification in Engineering Technologies (NICET) in electrical power distribution system testing.

D. The testing firm shall utilize technicians who are regularly employed by the firm for testing services.

E. The testing firm shall submit proof of the above qualifications in accordance with Par.1.06.

1.04 TEST EQUIPMENT:

A. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Split-core current transformers and clamp-on or tong-type ammeters require careful consideration of the following in regard to accuracy:
 - a. Position of the conductor within the core.
 - b. Clean, tight fit of the core pole faces.
 - c. Presence of external fields.
 - d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.
3. Selection of metering equipment should be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the de component. When the variable contains harmonics or de offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.
4. Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked.
5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.
6. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment

B. Test Instrument Calibration

1. The testing firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology. (NIST)
3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
 - b. Laboratory instruments: 12 months

- c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.
- d. Dated calibration labels shall be visible on all test equipment.
- e. Records, which show date and results of instruments calibrated or tested, must be up-to-date and shall be submitted in accordance with Par. 1.06.
- f. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
- g. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.05 DIVISION OF RESPONSIBILITY:

- A The independent testing contractor shall perform all tests as listed in this Section.
- B. The installation contractor may perform tests which are described in other specification sections. These include insulation resistance and continuity tests on low voltage equipment and circuits and high potential testing of medium voltage cable.

1.06 SUBMITTALS- FOR APPROVAL:

- A Qualifications Statement:
 - 1. Experience record on proposed testing firm to include client contact names and telephone numbers.
 - 2. Experience record on technicians who will perform testing work.
- B. Test Equipment
 - 1. Schedule of test equipment to be used for project.
 - 2. Calibration records for each item of test equipment.

1.07 SUBMITTALS- FOR CLOSE OUT

- A Field Test Reports- Submit the following data bound and indexed in a 3 ring loose leaf binder.
 - 1. Summary of project.
 - 2. Description of equipment tested and nameplate data.
 - 3. Description of tests.
 - 4. Test results.
 - 5. List of deficiencies observed and corrective action taken, if any.

6. Analysis and recommendations.

PART 2 PRODUCTS-NOT USED

PART 3 EXECUTION

3.01 FIELD TESTS

A Perform field tests and listed herein. Test procedures shall be in accordance with NETA Acceptance Testing Specifications. Dielectric test voltages applied to circuits and to equipment shall not exceed values or duration recommended by the equipment manufacturer.

B. Low Voltage Motor Starters:

1. Visual and Mechanical Inspection

- a. Compare equipment nameplate data with drawings and specifications.
- b. Inspect physical and mechanical condition.
- c. Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.
- d. Motor-Running Protection
 - 1) Compare overload element rating with motor full-load current rating to verify correct sizing.
 - 2) If power-factor correction capacitors are connected on the load side of the overload protection, include the effect of the capacitive reactance in determining appropriate overload element size.
 - 3) If motor-running protection is provided by fuses, verify correct rating considering motor characteristics and power-factor correction capacitors.
- e. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 3) Perform thermographic survey.

2. Electrical Tests

a. Insulation Tests

- 1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- 2) Measure insulation resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Refer to manufacturer's instructions for devices with solid-state components.
- 3) Measure insulation resistance of each control circuit-to-ground.
- 4) Perform an insulation resistance test at 1000 volts de on all control wiring. For units with solid-state components, follow manufacturer's recommendations.

- b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
NOTE: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to ANSI/NEMA ICS 2, Part 4.)
- c. Test circuit breakers, including motor circuit protectors, in accordance with Section 7.6.1.1.
- d. Perform operational tests by initiating control devices.

3. Test Values

- a. Compare bolted connection resistance to values of similar connections.
- b. Bolt-torque levels should be in accordance with values specified by manufacturer.
- c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
- d. Insulation-resistance values shall be in accordance with accepted values.
- e. Control wiring insulation test resistance should be a minimum of 500 megohms.
- f. Overload trip times shall be in accordance with manufacturer's published data.

C. Cables - Low-Voltage, 600 Volt Maximum

1. Visual and Mechanical Inspection

- a. Compare cable data with drawings and specifications.
- b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
- c. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- d. Perform thermographic survey.
- e. Inspect compression-applied connectors for correct cable match and indentation.
- f. Verify cable color coding with applicable specifications and the National Electrical Code.

2. Electrical Tests

- a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts de for 300 volt rated cable and 1000 volts de for 600 volt rated cable. Test duration shall be one minute.
- b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- c. Perform continuity test to insure correct cable connection.

3. Test Values

- a. Compare bolted connection resistance to values of similar connections.
 - b. Bolt-torque levels should be in accordance with values specified by the manufacturer.
 - c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
 - d. Minimum insulation-resistance values should not be less than 500 megohms.
 - e. Investigate deviations between adjacent phases.
- D. Switchgear and Switchboard Assemblies
- 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment
 - d. Inspect all doors, panels, and sections for corrosion, dents, scratches, fit, and missing hardware.
 - e. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
 - f. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 3) Perform thermographic survey.
 - g. Verify that current and potential transformer ratios correspond to drawings.
 - h. Compare equipment nameplate data with latest one-line diagram when available.
 - i. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 2) Make key exchange with devices operated in off-normal positions.
 - j. Thoroughly clean switchgear prior to testing.
 - k. Lubrication
 - 1) Verify appropriate contact lubricant on moving current-carrying parts.
 - 2) Verify appropriate lubrication on moving and sliding surfaces.
 - l. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - m. Verify correct barrier and shutter installation and operation.
 - n. Exercise all active components.
 - o. Inspect all mechanical indicating devices for correct operation.
 - p. Verify that filters are in place and/or vents are clear.

- q. Perform visual and mechanical inspection on all instrument transformers.
- r. Inspect control power transformers.
 - 1) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks

2. Electrical Tests

- a. Perform tests on all instrument transformers.
- b. Perform ground-resistance tests.
- c. Perform resistance tests through all bus joints with a low-resistance ohmmeter, if applicable.
- d. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute.
- e. Perform an overpotential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. The test voltage shall be applied for one minute.
- f. Perform insulation-resistance tests at 1000 volts de on all control wiring. For units with solid-state components, follow manufacturer's recommendations.
- g. Perform control wiring performance test.
- h. Perform current injection tests on the entire current circuit in each section of switchgear.
 - 1) Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.
 - 2) Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.
 - 3) Test current at each device.
- i. Determine accuracy of all meters and calibrate watt-hour meters. Verify multipliers.
- j. Perform phasing check on double-ended switchgear to insure correct bus phasing from each source.
- k. Control Power Transformers
 - 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.
 - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - 3) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 - 4) Verify correct function of control transfer relays located in switchgear with multiple power sources.
- l. Voltage Transformers

- 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.
 - 2) Perform secondary wiring integrity test. Confirm correct potential at all devices.
 - 3) Verify secondary voltages.
- m. Verify operation of switchgear/switchboard heaters.

3. Test Values

- a. Compare bus connection resistances to values of similar connections.
- b. Bolt-torque levels shall be in accordance those specified by manufacturer.
- c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar bus by more than 50 percent of the lowest value.
- d. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. Values of insulation resistance less than manufacturer's minimum shall be investigated. Overpotential tests should not proceed until insulation- resistance levels are raised above minimum values.
- e. The insulation shall withstand the overpotential test voltage applied.

E. Circuit Breakers - Low-Voltage - Insulated Case/Molded Case

1. Visual and Mechanical Inspection

- a. Compare nameplate data with drawings and specifications.
- b. Inspect circuit breaker for correct mounting.
- c. Operate circuit breaker to insure smooth operation.
- d. Inspect case for cracks or other defects.
- e. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 3) Perform thermographic survey.
- f. Inspect mechanism contacts and arc chutes in unsealed units.

2. Electrical Tests

- a. Perform a contact-resistance test.
- b. Perform an insulation-resistance test at 1000 volts de from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase
- d. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- e. Perform insulation resistance tests at 1000 volts de on all control wiring. Do not perform the test on wiring connected to solid state components.

- f. Perform adjustments for final settings in accordance with coordination study supplied by owner.
 - g. Perform long-time delay time-current characteristic tests by passing 300 percent rated primary current through each pole separately unless series testing is required to defeat ground fault functions.
 - h. Determine short-time pickup and delay by primary current injection.
 - i. Determine ground-fault pickup and time delay by primary current injection.
 - j. Determine instantaneous pickup current by primary injection using run-up or pulse method.
 - k. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
 - l. Verify the calibration of all functions of the trip unit by means of secondary injection.
3. Test Values
- a. Compare bolted connection resistance to values of similar connections.
 - b. Bolt-torque levels should be in accordance those specified by manufacturer
 - c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
 - d. Circuit breaker insulation resistance should be in accordance manufacturer's published data.
 - e. 5. Control wiring insulation resistance should be a minimum of 500 megohms.
 - f. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. Circuit breakers exceeding specified trip time at 300 percent of pickup shall be tagged defective.
 - g. Instantaneous pickup values of molded-case circuit breakers shall be within tolerances.

F. AC Motors

- 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Confirm correct application of manufacturer's recommended lubricants.
 - d. Inspect anchorage, and grounding.
 - e. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 3) Perform thermographic survey.
 - f. When applicable, perform special tests such as air gap spacing and pedestal alignment.
 - g. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
- 2. Electrical Tests- Induction Motors

- a. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
 - b. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
 - 1) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.
 - 2) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
 - c. Perform de overpotential tests on motors in accordance with ANSI/IEEE Standard 95.
 - d. Perform insulation power-factor or dissipation-factor tests.
 - e. Perform surge comparison tests.
 - f. Perform insulation-resistance test on pedestal in accordance with manufacturer's published data.
 - g. Test surge protection devices.
 - h. Test motor starter.
 - i. Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
 - j. Verify that the motor space heater is functional.
 - k. Perform a rotation test to insure correct shaft direction.
 - l. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
3. Electrical Tests- Synchronous Motors
- a. Perform all tests as indicated above for induction motors.
 - b. Perform a voltage-drop test on all salient poles.
 - c. Perform insulation-resistance tests on the main rotating field winding, the exciter-field winding, and the exciter-armature winding in accordance with ANSI/IEEE Standard 43.
 - d. Perform a high-potential test on the excitation system in accordance with ANSI/IEEE Standard 421B.
 - e. Measure and record resistance of motor field winding, exciter-stator winding, exciter-rotor windings, and field discharge resistors.
 - f. Perform front-to-back resistance tests on diodes and gating tests of silicon controlled rectifiers for field application semiconductors.
 - g. Prior to initial start, apply voltage to the exciter supply and adjust exciter-field current to nameplate value.
 - h. Verify that the field application timer and the enable timer for the power-factor relay have been tested and set to the motor drive manufacturer's recommended values.
 - i. Record stator current, stator voltage, and field current by strip chart recorder for the complete acceleration period including stabilization time for a normally loaded starting condition. From the recording determine the following information:
 - 1) Bus voltage prior to start.
 - 2) Voltage drop at start.
 - 3) Bus voltage at motor full-load.
 - 4) Locked-rotor current.
 - 5) Current after synchronization but before loading.
 - 6) Current at maximum loading.
 - 7) Acceleration time to near synchronous speed.
 - 8) RPM just prior to synchronization.
 - 9) Field application time.
 - 10) Time to reach stable synchronous operation.

- j. Plot a V-curve of stator current versus excitation current at approximately 50 percent load to check correct exciter operation.
- k. If the range of exciter adjustment and motor loading permit reduce excitation to cause power factor to fall below the trip value of the power-factor relay. Verify relay operation.

4. Test Values

- a. Compare bolted connection resistance to values of similar connections.
- b. Bolt-torque levels should be in accordance with values specified by manufacturer.
- c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
- d. Insulation-resistance test results shall be in accordance with manufacturer's published data. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B insulation and Class F insulation. NOTE: Overpotential, and surge comparison tests shall not be made on motors having values lower than those indicated above.
- e. Stator winding de overpotential test voltage shall be in accordance with NEMA publication MG 1, paragraph 3.01. Test results are dependent on ambient conditions, and evaluation is on a withstand basis. If phase windings can be separately tested, values of leakage current may be compared for similar windings.
- f. Vibration amplitudes shall not exceed values shown in manufacturer's published data.
- g. Salient pole voltage drop shall be equal for each pole
NOTE: For de tests each pole (or pair of poles) shall not vary more than two percent from the average. An ac test is more sensitive than a de test in determining shorted turns. A pole with shorted turns will have a substantially lower voltage than sound coils. Coils adjacent to coils with shorted turns will exhibit slightly lower voltage.
- h. The measured resistance values of motor-field windings, exciter-stator windings, exciter-rotor windings, and field-discharge resistors shall be compared to manufacturer's recommended values.

G. Adjustable Speed Drive Systems

1. Visual and Mechanical Inspection

- a. Compare equipment nameplate data with drawings and specifications.
- b. Inspect physical and mechanical condition.
- c. Ensure vent path openings are free from debris and that heat transfer surfaces are not fouled by oil, dust, or dirt.
- d. Motor Running Protection
 - 1) Compare drive overcurrent setpoints with motor full-load current rating to verify correct settings.
 - 2) If drive is used to operate multiple motors, compare individual overload element ratings with motor full-load current ratings.
 - 3) Apply minimum and maximum speed setpoints. Confirm setpoints are within limitations of the load coupled to the motor.
- e. Inspect all bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- 3) Perform thermographic survey.

2. Electrical Tests

- a. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element. NOTE: Test times for thermal trip units will, in general, be longer than the manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison (Refer to ANSI/NEMA ICS 2, Part 4.)
- c. Perform startup of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.
- d. Perform operational tests by initiating control devices.
 - 1) Check motor rotation operating on the drive and on the bypass.
 - 2) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual vibration. If excessive vibration occurs enter these critical frequencies into the drive's programmed step-over frequencies so operation at these speeds will not occur.
 - 3) Verify operation of drive from remote start/stop and speed control signals.
 - 4) Measure and record total harmonic distortion of current and voltage in accordance with IEEE 1159-1995.
- e. Test input circuit breaker by primary injection.f. Test for the following parameters in accordance with relay calibration procedures for protective relays:
 - 1) Input phase loss protection.
 - 2) Input overvoltage protection.
 - 3) Output phase rotation.
 - 4) Overtemperature protection.
 - 5) DC overvoltage protection.
 - 6) Overfrequency protection.
 - 7) Drive overload protection.
 - 8) Fault alarm outputs.

3. Test Values

- a. Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer's published time-current curve.
- b. Harmonic values at the point of common coupling shall be in accordance with ANSI/IEEE 519.
- c. When critical test points are specified, the relay shall be calibrated to specified critical points even though other test points may be out of tolerance.
- d. Bolt-torque levels shall be in accordance with Table 10.12 unless otherwise specified by the manufacturer.

- H. Grounding Systems
 - 1. Visual and Mechanical Inspection
 - Verify ground system is in compliance with drawings and specifications.
 - 2. Electrical Tests
 - a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.
 - b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - 3. Test Values
 - a. The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference: ANSI/IEEE Standard 142.)
 - b. Investigate point-to-point resistance values which exceed 0.5 ohm.

- I. Fiber-Optic Cables
 - 1. Visual and Mechanical Inspection
 - a. Compare cable, connector, and splice data with drawings and specifications.
 - b. Inspect cable and connections for physical and mechanical damage.
 - c. Verify that all connectors and splices are correctly installed.
 - 2. Electrical Tests
 - a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.
 - b. Perform connector and splice integrity test using an optical time domain reflectometer.
 - c. Perform cable attenuation loss measurement with an optical power loss test set.
 - d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set.
 - 3. Test Values
 - a. The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
 - b. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Design and installation of a complete lightning protection system.
 - 2. Materials and components for the lightning protection system.

- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 01312 – Project Meetings.
 - b. Section 01330 – Submittal Procedures.
 - c. Section 01614 – Wind Design Criteria.
 - d. Section 01770 – Closeout Procedures.
 - e. Section 16000 – Common Work Results for Electrical.
 - f. Section 16060 – Grounding and Bonding.

1.02 REFERENCES

- A. As specified in Section 16000.

- B. Lightning Protection Institute (LPI).

- C. National Fire Protection Association (NFPA):
 - 1. 780 – Standard for the Installation of Lightning Protection Systems.

- D. Underwriters Laboratories, Inc. (UL):
 - 1. 96 – Standard for Lightning Protection Components.
 - 2. 96A – Standard for Installation Requirements for Lightning Protection Systems.

1.03 DEFINITIONS

- A. As specified in Section 16000.

- B. Specific definitions:
 - 1. LPI: Lightning Protection Institute.

1.04 SYSTEM DESCRIPTION

- A. Retain the services of a lightning protection contractor to design, furnish, and install a complete lightning protection system, connected to the facility grounding system.
- B. Lightning protection system: NFPA 780; Class I UL 96A; master labeled system(s) protecting roof-mounted mechanical equipment, consisting of:
 - 1. Air terminals on roof(s).
 - 2. Bonding of structure and other metal objects.
 - 3. Grounding electrodes.
 - 4. Interconnecting conductors.
- C. Connect the lightning protection system to the facility grounding electrode:
 - 1. Provide common ground connections as necessary to the electric and telephone service conductors.
- D. The installing contractor is responsible for all costs associated with UL inspection of the lightning protection system, including any costs associated with re-inspection necessary to obtain the UL 96A Master Label.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Product data:
 - 1. Provide samples and pertinent catalog data for:
 - a. Air terminals.
 - b. Conductors.
 - c. Connectors.
 - d. Accessories.
 - e. Include dimensions and materials of each component, and include indication of listing in accordance with UL 96.
- C. Shop drawings:
 - 1. Including but not limited to:
 - a. Layout of air terminals with the respective configuration of the zone of protection.
 - b. Grounding electrodes, and bonding connections to structure and other metal objects.
 - c. Type, size and locations for:
 - 1) Terminal.
 - 2) Electrode.
 - 3) Conductor.
 - d. Conductor routing details.
 - e. Connection details.
 - f. Termination details.
 - g. Applicable air terminal and other calculations.
 - 2. Details showing installation of air terminals, conductors, and connectors.

- D. Record Documents:
 - 1. Provide Record Documents as specified in Sections 01770 and 16000.
 - 2. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.
 - 3. Manufacturer's installation instructions.

1.06 QUALITY ASSURANCE

- A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.
- B. Conform to the requirements of the UL and NFPA standards for lightning protection systems:
 - 1. Components shall be listed in accordance with UL 96.
- C. Manufacturer's qualifications:
 - 1. Company specializing in lightning protection equipment:
 - a. Listed in section "Lightning Conductor, Air Terminals and Fittings" of the UL "Electrical Construction Materials Directory" for at least 5 years previous to this Contract's bid opening date.
- D. The lightning protection system shall meet the applicable requirements of NFPA 780.
- E. Upon completion of installation the lightning protection contractor to have the building lightning system physically inspected by UL and furnish a UL Master Label for the building:
 - 1. Application for the UL Master Label without a physical inspection by UL is unacceptable.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

- A. Pre-installation conference:
 - 1. Convene a pre-installation conference with electrical sub-contractor 1 week before commencing the Work of this Section, as specified in Sections 01312 and 16000.
- B. Coordinate Work with other trades to ensure neat, correct, and unobtrusive installation.
- C. Coordinate the Work of this Section with roofing and exterior and interior finish installations.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.12 SYSTEM START-UP

A. As specified in Section 16000 and other pertinent sections of the Plans and Specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
1. Erico.
 2. Thompson Lightning Protection, Inc.
 3. Harger Lightning and Grounding.
 4. VFC, Inc.
 5. Bonded Lightning protection.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Air terminals:
1. Material: Copper.
 2. Size: 3/8-inch by 18-inch minimum extending a minimum of 12 inches above the object to be protected.
 3. On flat or walkable roofs, provide air terminals with:
 - a. Mushroom type blunt tip incapable of impalement if fallen upon.
 - b. Spring mounted and capable of being pushed flush to the roof.
 4. Air terminals on stacks and chimneys:
 - a. Protected from corrosion.
 - b. Sized in accordance with UL and NFPA requirements.
 - c. Lead-coated copper.
 5. Air terminal bases:
 - a. Cast bronze with bolt pressure cable connections securely mounted with stainless steel screws and bolts.
- B. Ground rods:
1. As specified in Section 16060.
- C. Ground plate: Copper.
- D. Conductors:
1. Perimeters:
 - a. Copper.
 2. Down conductors:
 - a. Copper.

3. At least 32 strands of 17 gauge or larger copper wire weighing not less than 215 pounds per 1000 feet.
 4. UL listed for the application.
 5. Copper:
 - a. Perimeters and down conductors:
 - 1) At least 32 strands of 17 gauge or larger copper wire weighing not less than 215 pounds per 1,000 feet.
 - 2) UL listed for the application.
 6. Cable fasteners:
 - a. Electrolytically compatible with conductors and mounting surface:
 - 1) Spaced in accordance with LPI and NFPA requirements.
- E. Connectors and splicers (Bronze):
1. Make connections between dissimilar metals with approved bimetallic connectors.
- F. Miscellaneous materials:
1. Copper of type and size recommended by the manufacturer of the lightning protection system.
 2. Stainless steel bolts, screws, and other threaded fasteners.
- G. System: Aluminum components for aluminum roofing, compatible with aluminum roofing materials; mechanical connectors and transition joints between aluminum and copper, suitable, properly installed by trained personnel.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. It is the responsibility of the lightning protection subcontractor to review the electrical system design, and provide any and all additional equipment and materials needed in order to construct a master labeled UL lightning protection system.
- B. Verify that surfaces are ready to receive Work.
- C. Verify that field measurements are as indicated on the Drawings or as specified

elsewhere in this Section.

- D. Protect elements surrounding Work of this Section from damage or disfiguration.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 16050.
- B. Install systems in accordance with manufacturer's instructions unless otherwise specified in this Section.
- C. Installation must be made under the supervision of an LPI certified master installer.
 - 1. Physically connect lightning protection equipment to structural roof framing members including metal deck. Do not attach lightning protection equipment to rigid roof insulation.
 - 2. Coordinate sealing roofing penetrations with Section 07415 to prevent leakage.
- D. Conductor installations:
 - 1. Install the lightning protection roof system(s) grounding and bending conductors exposed on flat roof areas and concealed at ridge roof areas.
 - 2. Install main downleads completely concealed and sleeved.
 - 3. Other than for the purpose of protecting downlead conductors from damage up to 6 feet above grade level, do not use exposed conduits to conceal the downleads on the exterior of the building(s) outside walls.
 - 4. Use minimum 1-inch PVC conduits to protect lightning system conductors from damage.
- E. Clearances: Assure 6-foot minimum distance required by NEC:
 - 1. From lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods.
 - 2. From lightning system conductors to open conductors of communication systems.
 - 3. From lightning protection grounding electrodes to electrodes of other grounding systems.
- F. Extend air terminals a minimum of 12 inches above object to be protected.
- G. Maintain horizontal or downward coursing of main conductor and ensure that bends have at least an 8-inch radius and that no bend of a conductor forms an included angle of less than 90 degrees.
- H. Install ground electrodes not less than 1 foot below grade and not less than 2 feet from foundation walls.
- I. Interconnection of metals:
 - 1. Bond all metal bodies within 6 feet of the conductor to the system with approved fittings and conductor.
 - 2. Connections between dissimilar metals shall be made with approved bimetallic connections.
 - 3. Bond metal bodies of inductance located within 6 feet of a conductor or object with secondary bonds.

- J. Bond all isolated metallic bodies at or below the roof subject to inductance and within 6 feet of lightning protection system conductors.
- K. Provide necessary common grounds between the lightning protection system and the electric and telephone service entrance wires, TV and radio antenna grounds.
- L. Ensure that air terminals are installed to withstand calculated wind force due to 100 miles per hour winds or as specified in Section 01614, whichever is greater with a 1.3 gust factor without structural damage and without damage to integrity of the lightning protection system.
- M. Protect down conductors entering corrosive soil against corrosion by a protective coating for not less than 3 feet above grade level and for the entire length below grade level until connection to the ground ring and rods.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 16050:
- B. Provide the services of UL to physically inspect the entire lightning protection system and issue the UL Master Label:
 - 1. Furnish UL Master Label as evidence that the installation has met with UL 96A code requirements.
- C. Obtain LPI system certification reports and LPI system certification.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17050
INSTRUMENTATION

PART 1: GENERAL

1.01 GENERAL

The General Conditions and Requirements, Special Provisions, and Electrical specifications are hereby made a part of this section.

B. The Instrumentation and Control Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the office of the Owner's representative and shall be examined by all bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

C. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable Instrumentation and Control system as defined by the contract documents.

D. The Contractor is responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly.

E. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition. Further, It is the intent of these plans and specifications that the I & C contractor shall provide an Open Architecture SCADA/Control system, where as the Owner can maintain, change/alter, or expand the system as the Owner deems necessary after the warranty period at no additional cost to the Owner. Further all programming keys, ladder logic, and Owner's manuals shall be submitted to the Owner as needed to meet this intent.

F. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standard Institute

SECTION 17050
INSTRUMENTATION

4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

H. The use of the word “*furnish*” or “*Install*” or “*provide*”, shall be taken to mean that the item or facility is to be both furnished and installed under this section unless specifically stated to the contrary that the item or facility is to be furnished under another section and installed under this section; furnished under this section and installed under another section; or furnished and installed under another section.

I. The use of the term “as or where Indicated”; “as or where shown”; “as or where specified”; or “as or where scheduled” shall be taken to mean that the reference is made to the contract documents either under the drawings and/or the specifications.

1.02 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the Instrumentation and Control system installation shall conform to the latest edition of the National Electrical Code as well as all other State and Local codes and applicable standards.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these prior to bid time.

1.03 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. All materials and equipment shall be of the highest quality in order to provide the most reliable end product possible. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)

B. The definition of terms used throughout the contract documents shall be as specified

SECTION 17050
INSTRUMENTATION

by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturer's Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code
6. National Fire Protection Association

C. Submit copies of applicable standards with each submittal

D. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

E. All products shall bear UL labels where standards have been set for listing.

1.04 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings shall be taken mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

C. Submit for review in sextuplet within sixty (60) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and submittals are not received in sixty (60) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne by the contractor.

D. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.

E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's representative and such procedures will not be cause for delay. After final review, supply up to six (6) copies, if requested.

SECTION 17050
INSTRUMENTATION

G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each Submittal and/or shop drawing.

H. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.

I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent.

J. Materials to be submitted are as follows:

- | | |
|--------------------------------|--|
| 1. Sensors | 8. PLC |
| 2. Logic Ladder Diagrams | 9. PLC Software (Reporting Software, PLC Software, etc.) |
| 3. Control Panels | |
| 4. Wiring Devices | |
| 5. HMI Screen Shots | |
| 6. Level/Pressure Transmitters | |
| 7. Flow Meters | |

K. Each submittal shall be accompanied with a written statement certifying that the submitted equipment and/or material meets the plans and specifications.

1.05 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The Submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed

SECTION 17050
INSTRUMENTATION

item specified.

1.06 EXCAVATION AND BACKFILLING

- A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.
- B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.
- C. All backfilling shall be made with selected soil; free of rock and debris and shall be pneumatically tamped in six (6") inch layers to secure a field density ratio of 90%.
- D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.
- E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.
- F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

1.07 CUTTING AND PATCHING

- A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.
- B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.
- C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.
- D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

SECTION 17050
INSTRUMENTATION

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

G. No cutting of structural elements shall be done without permission of the Engineer.

1.08 WATERPROOFING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

B. Flashing for conduit penetrations through built-up roofs shall be made with pitch pans filled with pitch. Conduit penetrations through poured concrete roofs shall be made with sleeves and annulus caulked.

C. Penetrations through walls at below ground elevations shall be waterproofed by conduit sealing fittings or other methods as indicated.

D. Interiors of raceways that are likely to have water ingress such as runs from handholes into below-grade installations shall have waterstops installed to prevent water from entering into installations.

E. It is the responsibility of the Contractor to follow all applicable codes and standards for installation of electrical equipment in all hazardous locations, whether these locations are indicated on the plans and specifications. All electrical penetrations to junction boxes, control panels, shall be sealed with an acceptable sealed connector to avoid the entrance of harmful gasses or corrosive liquids that electrical raceway or electrical equipment may be exposed to. The Contractor must submit on the connectors for approval before use.

1.09 CONSTRUCTION REQUIREMENTS

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the engineer in advance of construction. Confirmed locations shall be made for the following:

1. Poles
2. Rough-ins and connections for equipment furnished under other sections
3. Control Panels, etc

B. Where equipment is being furnished under another section, request from the Engineer an accepted drawing that will show exact dimensions of required locations of connections. Install the required facilities to the exact requirements of the approved drawings

SECTION 17050
INSTRUMENTATION

C. All work shall be done in the best and most workmanlike manner by qualified careful electricians/technicians who are skilled in their trade. The standards of work required throughout shall be of the first class only and work that is unsatisfactory to the Engineer shall be instantly dismissed from the work upon written notice from the Engineer. All work must meet the approval of the Engineer.

D. Unless shown in detail, the drawings are diagrammatic and do not give exact details as to the elevations and routing of conduits, nor do they show all offsets and fittings. Nevertheless, the installation must be made to fit conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are shown, confirm locations and routing prior to installation with Engineer.

E. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole punch. Cutting openings with a torch or other device that produces a jagged edge, rough cut will not be acceptable. Top penetrations shall not be acceptable under any means.

F. Raceway entry into equipment shall be carefully planned. Cutting of enclosure framework to accommodate poorly planned raceway placement will not be acceptable. No hole punch penetrations shall be made on top of any equipment, panel, or Junction box. All hole punch penetrations shall be properly sealed so as to prevent moisture and gasses from entering the equipment, panel, of Junction Box etc....

G. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be acceptable.

H. Equipment, inclusive of supporting devices, shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid tight fitting manner.

1.10 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

E. Interiors of Control Panels, shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200 watt Lamp located the bottom of each

SECTION 17050
INSTRUMENTATION

section, or panel. Energizing integral condensation heaters shall be acceptable in place of lamps.

1.11 COOPERATION WITH WORK UNDER OTHER SECTIONS

- A. Cooperate with all other trades so as to facilitate the general progress of the work. Allow other trades every reasonable opportunity for then installation of their work and the storage of their materials.
- B. the work under this section shall follow the general construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before any concrete is placed or masonry is installed.
- C. Work with other trades in determining exact locations of outlets, conduits, fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.
- D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime as required to accomplish these requirements if directed to do so.
- E. The I&C Contractor shall coordinate all work with the General Contractor. The equipment provided by the I&C Contractor shall work with all of the features included in the equipment provided by others. It is the responsibility of the I&C Contractor to coordinate with all other parties so as to ascertain the required information in order to provide a fully functional workable system and to adjust his bid accordingly to meet this goal. Any deviations from the plans and specs shall be reported to the Engineer before bid time.

1.12 INSTALLATION AND CONNECTION OF WORK UNDER ANOTHER SECTION

- A. Ascertain all requirements for proper installation of any Electrical/Control equipment either provided by this section and required for installation by this section or provided by any other section and required for installation by this section.
- B. Verify the electrical capacities of all electrical equipment furnished under other sections, or furnished by the Owner, and request wiring information from the Engineer if wiring requirements are different from that specified under this section. Do not make rough-ins until equipment verification has been received.
- C. All controllers, terminal boxes, pilot devices, and miscellaneous items of electrical equipment that are not integrally mounted with the equipment shall be securely mounted and adequately supported in a neat workmanlike manner.

SECTION 17050
INSTRUMENTATION

1.13 CLEAN-UP

- A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.
- B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.
- C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.15 RECORD DRAWINGS

- A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.
- B. Show conduit routing and wiring runs as constructed and identify each.
- C. Record all deviations from the Contract Documents.
- D. Submit set of marked-up drawings for review.

1.16 OPERATIONS AND MAINTENANCE MANUALS

- A. Six (6) weeks prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.
- B. Submit six (6) copies for review.

PART 2 PRODUCTS

2.01 LABELS

- A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.
- B. Numbered marking labels shall be colored vinyl markers, T&B, Brady, or equal.
- C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.

SECTION 17050
INSTRUMENTATION

D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking "BURIED CONDUIT", or similar language, along its length.

E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with white engraving. Attachment means shall be self-tapping stainless steel screws.

2.02 GROUNDING DEVICES

A. Exothermally welded joints shall be made with Enrico "cadweld", Burndy "Thermweld", or equal kits.

B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.

C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.

2.03 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be grade 316 stainless steel; 1-5/8" wide x 3-1/4" deep. Clamp nuts and mounting hardware for use with slotted channels shall be grade 316 stainless steel.

C. Conduit straps for use with slotted channels shall be stainless steel with stainless steel hardware.

D. Concrete and Masonry Anchors shall be stainless steel type. Furnish Hilti, or equal.

E. Poles for supporting outdoor control panels shall be Hot Dipped Galvanized, with footings encased in concrete. Tops of poles shall be covered with a Hot Dipped Galvanized conduit cap.

H. "U" bolts shall be stainless steel galvanized steel with galvanized hex-head bolts.

I. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.4 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

SECTION 17050
INSTRUMENTATION

- B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.
- C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.
- D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.
- E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.
- F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.
- G. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.
- H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

PART 3: INSTALLATION

3.01 WIRING

- A. All control wiring, 120/240V wiring and insulated equipment grounding conductors shall be type THHN/THWN insulated stranded copper conductors.
- B. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.
- C. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.
- D. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.
- E. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment as required. Number selected shall correspond to number on terminal strip.

SECTION 17050
INSTRUMENTATION

- F. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.
- G. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

3.02 GROUNDING

- A. Each item of equipment shall be adequately and thoroughly grounded. Comply with Article 250 of N.E.C., except where higher standards of grounding have been specified.
- B. Equipment grounding conductors (EGC) shall be installed where indicated. These wires shall be green colored in sizes #6 AWG and smaller and green banded in larger sizes.
- C. EGC runs into equipment and shall be grounded to equipment bus where available, or to equipment ground lugs.
- D. Where grounding type bushings are installed, bond EGC thereto and furthermore ground each bushing lug to equipment ground bus or ground lug, or ground rod.
- E. In each motor terminal box, install equipment ground lug and connect EGC thereto.
- F. In each floodlight pole, install ground connector to pole and bond to conduit bushing and to EGC in branch circuit.

3.03 LABELING

In addition to requirements for labeling as specified throughout this section, install as follows:

- A. Phase bank each power wire and cable with colored banding tape. Do this at each termination.
- B. Apply numbered wire marking labels to control wires; power wiring in panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.
- C. Apply write-on identification labels to wiring sets in each hand-hole to identify

SECTION 17050
INSTRUMENTATION

function. Use waterproof labels.

D. Apply write-on identification labels to empty conduits to identify each with information as to terminus of other end and also trade size of conduit.

E. Install micarta nameplates with engraving to identify function and/or load served for the following:

1. Pump Control Panels, Panelboards, Overcurrent Devices, Motor Control Center, any newly installed work including Micarta nameplates shall be attached with stainless steel screws, use two (2) per each nameplate. Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.

F. Type circuit directory information on circuit directory cards on all panelboards.

CONTROL & INSTRUMENTATION

PART 1: GENERAL

1.01 SCOPE

A. Furnish and install control panels in the locations shown on the plans and as required.

B. Furnish and install control panels and remote control system as indicated on the plans.

C. Products and installations shall comply with the electrical section specifications including all applicable codes and standards.

D. The Contractor shall obtain the required electrical and telephone service as applicable at each location. The Contractor must coordinate his construction activities with the local utilities where applicable.

1.02 EQUIPMENT FIELD SERVICE

A. Provide the services of factory trained personnel to assist in the installation and start-up of the control system.

B. Provide at least four (4) hours on site time of factory trained personnel for training plant personnel on the operation and maintenance of the equipment.

SECTION 17050
INSTRUMENTATION

PART 2 PRODUCTS

1.0 GENERAL PANEL CONSTRUCTION/RTU - Contractor shall refer to Section 17710.

- A. Panel wiring shall be NEMA Class B.
- B. Control panel shall be Stainless Steel NEMA 4X gasketed enclosure with heat barriers and shall be as follows:
1. Enclosures shall be fabricated of Stainless Steel and adequately braced and reinforced as required with a NEMA 4X rating. Enclosure shall be manufactured with mounting provisions so that it can be properly braced by unistrut and/or supporting poles without the need to penetrate the enclosure for supporting means. Enclosures shall be Hoffman or equivalent.
 2. The control panels shall include mounting of hand-off-auto switches, indicating lights, and elapsed time meters, etc, as required suitable for outdoor use. The installation of this equipment shall not lessen the required NEMA 4X rating.
 3. Enclosures shall have stainless steel with butterfly type quick-release latches and one stainless steel hasp latch for padlocking.
 4. A 15A 120V convenience receptacle shall be installed in every panel
 5. Disconnect device operating handles shall have on-off positions clearly marked with provisions for pad-locking provisions. This device will be installed so that it can be operated without the need to open the enclosure where applicable.
 6. All control wiring shall be functionally color coded using factory pigmented insulation. Repeated colors shall be identified with Brady "sleeve type" numbered wire markers at each termination. Colors and numbers used shall correspond with colors and numbers shown on shop drawings control diagram. The use of only red for the color of control wire functions will not be acceptable. Use pigmented colored insulation for power (as per NEC); green shall be used for equipment grounding conductors; white or gray shall be used for grounding conductors; each rung of the ladder diagram shall have one of the remaining colors listed and shall be numbered as required above. Red shall be used from the transformer secondary fuse to the first device(s). Minimum wire size shall be #12 AWG.
 7. All control relays shall be industrial type each with 10-amp, 120V rated contacts. Each contact shall be field convertible. Each relay shall have open-close position indication. Relay coils shall be rated 120V A.C. continuous duty, including the latch type relay coils.

SECTION 17050
INSTRUMENTATION

8. All alternator relays shall be industrial type with 10-amp, 120V rated contacts. Furnish Furnas Class 47 or approved equal alternators. Where applicable
9. Each control panel shall be equipped with a lightning arrester connected to the 120VAC breaker. Furnish Square D #J9200-9A lightning arrester or approved equal.
10. All analog signals shall be supplied with Lighting Surge suppression. The contractor shall submit on LSA arrester intended for use.
11. All RTU panels shall be provided with a 120V, 20A Circuit Breaker from a nearby distribution panel. The contractor shall verify that all loading is acceptable and make accommodations to provide additional power circuits as required. Each panel shall be equipped with a fused control power transformer (CPT) as required. VA capacity of CPT shall be sized to handle its controller load plus external connected loads. Radio control panels (Local and Remote) shall have local power brought into each panel by contractor from spare circuit breakers.

2.0 Components (Not Used)

Part 3 Loop Descriptions

This section will provide a general description of anticipated control loops that are necessary to provide control functions as shown on the Drawings and as specified including any other equipment, accessories, and appurtenances as required for a complete and operable system. The I&C Contractor shall provide instrumentation hardware as necessary to perform the following functions. It is understood that the majority of the equipment shall be provided by one manufacturer. Further all panels for this equipment will be provided by this manufacturer's Panel supplier, either internal to the company or otherwise. As such it is understood that there will be variations to this specification as per said manufacturer's standard panels and control schemes. These variations shall be acceptable with a SCADA submittal outlining all variations. Further, the following control scheme is intended to include all supplemental control needs at the WTP and as such accommodations should be made in the Main RTU to accept these additions.

1.0 RTU Panel Description (Existing)

The I&C Contractor shall provide communications link from the proposed VFD to the existing Remote Terminal Unit. This communications link shall be made via a network cable connected between the two units. The Contractor shall provide all necessary network cabling and network components such as network switches power supplies etc. as needed. The Contractor shall provide all hardware required to achieve the required tasks. Further the Contractor shall provide all hardware/software and

SECTION 17050
INSTRUMENTATION

programming necessary to give the Owner the status and control of the proposed VFD and motor as well as the ability to record, report, and visually show the variables as required to make reports for Management and Governmental entities as required.

A. Liftstation RTU Panel Description – (Existing) The Existing RTU cabinet shall receive a Network cable from the proposed Variable Frequency Drive. This Network Cable shall be cable of passing the signals as described below. The Contractor shall provide all hardware including, but not limited to wiring, conduits, conduits supports, fuses, Network equipment, ...etc to achieve the required tasks. The power supply to this RTU shall be 120VAC +/- 15% @ 50/60 Hz from a nearby distribution panel.

Loop 100

A. VFD Control

1. The Pump in this panel shall have the following functionality in the MRTU:

- (YA 102) shall be a signal from the VFD to indicate the status of the Pump. The switch shall be a manual hand switch located on Pump VFD. A signal from the Pump VFD (Y1 101) shall indicate that the pump is in run or stop mode. A signal (YA 104) shall provide a pump Shut Off from the HMI at the operator's station.
 - In Auto Mode the MRTU; In Automatic mode a contact from the VFD shall indicate that the Motor Starter is running the pump (HS 101).
 - The HMI will provide a speed control (SC 101). This Signal shall originate in the MRTU and transmit via the same Network Cable. The signal shall provide a speed signal to the VFD to require more or less speed as needed.
 - The Pump VFD shall have the ability to generate an analog signal (SI 101). This signal shall provide realtime feed back of the pump speed on the HMI screen to allow the Operator the information needed to calculate dosage.
 - In Hand Mode all Automatic Control shall be bypassed and an indication on the TOUCHPAD shall indicate that the pumps is running. Local control shall be indicated by a contact (HS X01).
 - At the Pump a hand switch (HS 101) shall provide a Run/Stop signal to the Pump VFD.

SECTION 17050
INSTRUMENTATION

- In this mode the chemical shall be administered via the manual controls on the interface of the Pump VFD.
- In the event that the Pump is called to run but does not send a run status with a 10 second period (the contractor shall leave this time band adjustable), the HMI will indicate a Pump Fault Failed to Start alarm and activate General Alarm (YA 103)
- Other indications from contacts in the field and indicated on the HMI shall be as follows:
 - Leak alarm shall tie in any leak alarms available on the pump skid (YA X01)
 - Head Cover status shall come from a contact at the pump VFD and shall indicate the pump is not ready to run (Y1 102)
- Each motor shall have its own Pressure Switch (HS 102). This signal shall originate in the HMI and allow for a reset of the Trouble Alarm once the issue is rectified.

SECTION 17720

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Programmable logic controller (PLC) based control systems hardware.
 - 2. Development software to be used with the specified PLC hardware.
- B. Related sections:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
 - 3. Section 17733 - Control Systems: Network Materials and Equipment.
 - 4. Section 17762 - Control Systems: PCS Software.

1.02 REFERENCES

- A. As specified in Section 17050.
- B. Institute of Electrical and Electronics Engineers (IEEE).

1.03 DEFINITIONS

- A. As specified in Section 17050.
- B. Specific definitions:
 - 1. CPU: Central processing unit.
 - 2. I/O: Input/Output.
- C. Specific definitions:
 - 1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
 - 2. Application software: The software that is programmed specifically for the Project.

1.04 SYSTEM DESCRIPTION

- A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 and 17050.
- B. Product data:
 - 1. CPU:
 - a. Processor type.

- b. Processor speed.
 - c. Memory.
 - d. Internal processor battery back-up time.
 - 2. I/O modules:
 - a. Type.
 - b. Standard wiring diagram.
- C. Calculations:
 - 1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
 - 2. Submit calculations to verify that spare I/O requirements of this Section are met.
 - 3. Submit calculations to verify that PLC power supply requirements of this Section are met.
- D. Product data:
 - 1. Programming languages.
 - 2. Operating system requirements.
- E. Control logic:
 - 1. Fully annotated copy of programmed PLC logic.
 - 2. Cross-referenced index of all PLC registers or points.
- F. Provide application software for the specific Project process requirements.
 - 1. Fully annotated copy of programmed PLC logic in its native format.
 - 2. Cross-referenced index of all PLC registers or points.

1.06 QUALITY ASSURANCE

- A. As specified in Section 17050.
- B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.
- C. Additional requirements:
 - 1. Provide PLC system components by a single manufacturer:
 - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
 - 2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
 - 3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 17050.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 17050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

A. As specified in Section 17050.

B. In addition to the spare parts requirements specified in Section 17050

1. CPU: 1 spare for each type of CPU in the system.
2. I/O cards: 3 spares for each type of I/O card in the system.
3. Power supplies; 2 spares for every power supply in the system.
4. Network/communications cards: 1 spare for every network or communications card in the system.
5. Remote adapter: 1 spare for every remote adaptor in the system.
6. Chassis: 1 spare for each chassis size in the system.

C. Installed spare requirements:

1. I/O points:
 - a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC and remote inputs and outputs (RIO).
 - b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
2. PLC backplane capacity:
 - a. Provide 25-percent or 3 spare backplane slots, whichever is greater in all racks containing I/O.
3. PLC memory:
 - a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers:

1. Rockwell Automation:
 - a. 1756 ControlLogix.
 - 1) PCM-HW
 - 2) PCM-AD
 - b. 1768 CompactLogix
 - 1) VCP-04.5100
 - 2) VCP-04.5150
 - 3) VCP-04.5200

- 4) VCP-04.5250
- 5) VCP-04.6160
- 6) VCP-04.6250
- 7) VCP-08.1010

B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:

1. Rockwell Software:

a. Studio 5000.

- 1) Latest major release that has been out for at least a year.
- 2) Provide one licensed copy of PLC programming software to the Owner.

C. The LOI programming software system shall be manufactured by PLC hardware manufacturer:

1. Rockwell Software:

a. FactoryTalk View Machine Edition.

- 1) Latest major release that has been out for at least a year.
- 2) Provide one licensed copy of LOI programming software to the Owner.

D. The HMI programming software system shall be manufactured by PLC hardware manufacturer:

1. Rockwell Software:

a. FactoryTalk View Site Edition.

- 1) Latest major release that has been out for at least a year.
- 2) Provide one licensed copy of HMI programming software to the Owner.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Programmable logic controller:

1. Construction:

a. Furnish plug-in modular system.

b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:

- 1) Temperature: 0 to 60 degrees Celsius.
- 2) RFI: 80 to 1,000 MHz.
- 3) Vibration: 10 to 500 Hertz.
- 4) Humidity: 0 to 95 percent.

c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.

d. Design the PLC system to function as a stand-alone unit that performs all of the control functions described herein completely independent from the functions of the SCADA system PC-based operator interfaces:

- 1) Failure of the SCADA system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.

2. CPU:
 - a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
 - b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
 - c. Capable of supporting and implementing closed loop floating-point math and PID control that is directly integrated into the CPU control program.
3. Memory:
 - a. Non-volatile memory: On-board complementary metal oxide semi conductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.
 - b. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
 - 1) Reserve capacity:
 - a) Totally free from any system use.
 - 2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.
4. Programming:
 - a. Provide a system where processors are programmed by:
 - 1) Portable laptop computer both locally and via the PLC control network.
5. PLC power supply:
 - a. Input: 120 VAC.
 - b. Mounted in the PLC housing or as indicated in the Drawings.
 - c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
 - d. Provide redundant power supply.
6. PLC input/output, I/O modules:
 - a. General:
 - 1) Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
 - 2) Provide I/O modules that:
 - a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
 - b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
 - c) Accept dual-ended inputs.
 - 3) The use of common grounds between I/O points is not acceptable.
 - 4) Provide modules that are removable without having to disconnect wiring terminals:
 - a) Utilize a swing-arm or plug-in wiring connector.
 - 5) Provide at each PLC the I/O modules for the following:
 - a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
 - b) Installed spare capacity in accordance with the requirements of this Section.
 - c) Wire all spares provided to the field terminal strip.

- 6) Condition, filter, and check input signals for instrument limit conditions.
 - 7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
 - 8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
 - 9) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
 - 10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.
- b. Discrete input modules:
- 1) Defined as contact closure inputs from devices external to the input module.
 - 2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
 - 3) Individually isolated inputs.
 - 4) With LED's to indicate status of each discrete input.
 - 5) Input signal level: As indicated in the schematics and as required to interface with the equipment and instruments. It is most desirable to stick with a signal voltage level where possible.
 - 6) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
 - a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.
- c. Discrete output modules:
- 1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
 - a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
 - 2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
 - 3) LEDs to indicate status of each output point.
 - 4) Each output point: Individually isolated.
- d. Analog input modules:
- 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
 - 3) The analog-to-digital conversion updated with each scan of the processor. Individually isolated each input. Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
- e. Analog output modules:

- 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Individual isolated output points each rated for loads of up to 1,200 ohms.
 - 3) HART analog input module:
 - a) Channels per module: 8 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.
 - d) Flash-upgradeable firmware.
 - e) Slot in PLC backplane.
 - f) Uses standard PLC terminal blocks to allow use of pre-wired I/O cable system.
 - g) Modules shall be configured using the specified PLC programming software.
7. Communications modules:
- a. Network communications modules:
 - 1) General:
 - a) Install communications modules in the PLC backplane.
 - 2) Ethernet:
 - a) Ports: 1 RJ-45.
 - b) Communication rate: 10/100 Mbit/s.
 - 3) Modbus:
 - a) Ports: 1.
 - b) Each port individually configurable as Modbus Master or Slave.
 - c) Manufacturer:
 - (1) ControlLogix PLC:
 - (a) Prosoft Model MVI56E-MCM or equivalent product.
 - 4) Optical Communication:
 - a) Manufacturer:
 - (1) Phoenix Digital.
 - (a) 1756 Plug-In Module Model OCX-ETF-85-D-SC or approved equal for ControlLogix PLC.
 - (b) 1768 Plug-In Module Model OCP-ETG-85-D-SC or approved equal for CompactLogix PLC.
 - 5) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
8. PLC backplane housing:
- a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
 - b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
 - c. Provide a blank slot filler module for each spare slot.
- B. SCADA system interface:
1. As specified in Section 17733 and Section 17762.
- C. PLC programming software:
1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:

- a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
- b. Monitor devices at each drop on the PLC data network for proper communications.
- c. Provide the ability to program all PLCs on the PLC data network from the Engineer's console.
2. PLC Programming Laptop/Desktop Operating system :
 - a. Microsoft Windows 7.
3. The PLC programming software shall be suitable for the PLCs specified above.
4. PLC programming software for all programming, monitoring, searching, and editing:
 - a. Usable both on-line, while connected to the PLC, and off-line.
 - b. The operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
 - c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic, forced elements shall be identifiable by means of color change.
 - d. Include a search capability to locate any address or element and its program location.
 - e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
5. The PLC programming software shall support the following programming languages:
 - a. Ladder Diagram.
 - b. Function Block Diagram.
6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
 - a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
 - b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
 - c. Use a mnemonic associated with each contact, coil, etc. that describes its function.
 - d. Utilize the tag and loop identification as contained in the P&IDs:
 - 1) If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.
 - e. Provide a cross-reference report of program addresses.
7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
 - a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
 - 1) Respond to demands from a program request.
 - 2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
 - 3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.

- 4) Queuing of requests in order of priority if one or more requested resources are unavailable.
 - 5) Resolution of contending requests for the same resource in accordance with priority.
 - 6) Service requests for execution of one program by another.
 - 7) Transfer data between programs as requested.
 - 8) Management of all information transfers to and from peripheral devices.
 - 9) Control and recovery from all program fault conditions.
 - 10) Diagnose and report real-time hardware device errors.
8. Program execution:
- a. Application software - program execution scheduled on a priority basis:
 - 1) A multilevel priority interrupt structure is required.
 - 2) Enter into a list of pending programs a program interrupted by a higher priority program:
 - a) Resume its execution once it becomes the currently highest priority program.
 - 3) Schedule periodic programs.
 - 4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
9. Start-up and restart:
- a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
 - b. Initialization:
 - 1) Determination of system status before start-up of initializing operating system software and initializing application software.
 - 2) Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.
10. Shutdown:
- a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
 - b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
 - c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
 - d. Alarm PLC failure at the operator interface level.
11. Diagnostics:
- a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
 - b. Use the manufacturer's standard diagnostic routines as much as possible.
 - c. Furnish diagnostic software and test programs for each significant component in the control system.
 - d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
12. Calendar/time program:
- a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system level and application software.

- b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
 - c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
13. Algorithms:
- a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
 - b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
 - c. Algorithms must include alarm checks where appropriate.
 - d. Provide, as a minimum, the following types of algorithms:
 - 1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
 - 2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
 - 3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supporting both direct and reverse-acting modes.
 - 4) Lead, lag, dead time, and ratio compensators.
 - 5) Integration and totalization of analog process variables.
14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
- a. In addition, provide spare database points for future expansion.
15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case the database for each point must include all specified aspects.
16. All portions of the database must be available for use by the display, report, and other specified software modules.
17. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:
- a. Analog input signal types:
 - 1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
 - b. Input accuracy:
 - 1) Inputs must be read with an accuracy of within 0.05-percent full scale or better.
 - 2) Data conversion errors must be less than 0.05-percent full scale.
 - 3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once a minute.
 - 4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
 - c. Blocking:
 - 1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.

- 2) For any input so blocked, the operator may manually enter a value to be used as the input value.
- d. Filtering:
 - 1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
- e. Linearizing:
 - 1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
- f. Calculated values:
 - 1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc.
 - 2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.
- g. Scaling and zero suppression:
 - 1) Provide a conversion program to convert input values into engineering units in a floating-point format.
- h. Alarms:
 - 1) Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.
 - 2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
 - 3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
 - 4) Report return to normal shall also be reported.
 - 5) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.
- i. Averages:
 - 1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
 - 2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
 - 3) Update hourly averages each minute or at the polling interval for the selected variable.
 - 4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
 - 5) Update monthly averages at least once each day and calculate using the results of the daily averages.
 - 6) At the end of each averaging period, store the average values for the period on the hard disk for historical record keeping and reset the present period average register to the present value of the variable.
 - 7) The active database must include the present period average and previous period average for each variable and averaging period.
- j. Totals:
 - 1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
 - 2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
 - 3) Assign a separate factor for each totalizing interval.

- 4) Variables for which totalization is inappropriate must have scaling factors of zero.
 - 5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record keeping and reset the present period totalization register to zero.
 - 6) The active database must include the present period total and previous period total for each variable and totalizing period.
- k. Engineering units:
- 1) Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
 - 2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.
 - 3) Pre-program the conversion of the engineering units, and if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
 - 4) The programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.
 - 5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.
- l. Control modules:
- 1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
 - 2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
 - 3) Provide control algorithms for manual control with output values adjustable by the operator.
- m. Analog outputs:
- 1) Analog outputs must be maintained as part of the database.
 - 2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.
18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. General control functions:

1. Analog control functions:
 - a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
 - b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.
 - c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
 - d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.
2. Discrete control functions:

- a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.
 - 3. Software support:
 - a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
 - b. Call each function as required by the configured controls to perform the intended function.
 - 4. Control and status discrepancies:
 - a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
 - 1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
 - b. Involuntary change in the device's status must also generate an alarm:
 - 1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
 - c. Each command, status, and alarm must cause the color of the symbol to change.
 - d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
 - 1) Delay periods for each final control element must be adjustable at the operator interface.
 - 2) List all time delays in the final documentation.
 - 5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- E. Control configuration:
- 1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
 - 2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints and tuning constants, etc.
 - 3. Provide a mechanism to link separate control functions together into an integrated control strategy.
 - 4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
 - 5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU and to upload them to the operator interface for operational record keeping.
 - 6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.
- F. Remote inputs and outputs (RIOs):
- 1. Compatible with all of the PLCs being furnished under this Contract and shall be by the same manufacturer as the PLCs, and as a minimum, includes:
 - a. Power supply.

- b. Rack.
 - c. Backplane.
 - d. Communications module.
 - e. I/O modules.
 - f. Enclosure.
2. Provide all cables and software needed for a complete and operational RIO system as specified in the Contract Documents.
 3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.
 4. The control system must continue operation should a fault occur on a single RIO drop:
 - a. Upon clearing the fault, restart communications to that drop automatically.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. As specified in Section 17050.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 17050.
- B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
 1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- D. General:
 1. The control system logic program shall reside at the PLC level.
- E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.

- F. Program the PLC logic using the following language(s):
 - 1. Ladder Diagram.
 - 2. Function Block Diagram.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. Provide a minimum of 4 CD/DVD copies of the following:
 - 1. Application software:
 - a. Finalized fully annotated copy of programmed PLC logic in its native format.
 - b. Cross-referenced index of all PLC registers or points.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 17050.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

- A. As specified in Section 17050.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 17050.
- B. Tailor training specifically for this Project that reflects the entire control system installation and configuration.
- C. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:
 - 1. A representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.
 - 2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.11 PROTECTION

- A. As specified in Section 17050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17721

CONTROL SYSTEMS: LOCAL OPERATOR INTERFACE (LOI)

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Local operator interface (LOI) control systems hardware and software.
- B. Related sections:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.02 REFERENCES

- A. As specified in Section 17050.

1.03 DEFINITIONS

- A. As specified in Section 17050.

1.04 SYSTEM DESCRIPTION

- A. Provide all LOI hardware identified in the Contract Documents.

1.05 SUBMITTALS

- A. Furnish submittals in accordance with Sections 01330 and 17050.
- B. Product data:
 - 1. Complete manufacturer's brochures for each item of equipment.
 - 2. Complete manufacturer's brochures that identify LOI software and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
 - 3. Manufacturer's operation and installation instructions.
 - 4. Additional requirements:
 - a. Display type and size.
 - b. Operator input.
 - c. Processor type and speed.
 - d. Memory size.
 - e. Programming protocols.
 - f. Communication protocols.
 - g. Power requirements.
 - h. Operating temperature and humidity ranges. NEMA ratings.

- C. Shop drawings:
 - 1. Furnish the following:
 - a. System block diagram showing relationship and connections between devices. Include manufacturer and model information, and address settings.
 - b. Mounting drawings with dimensions and elevations for each equipment location, including identification of all components, preparation and finish data, and nameplates.
 - c. Electrical connection diagrams.
 - d. Complete grounding requirements.
 - 2. Graphic Screens:
 - a. Color printouts of each graphic screen and all control pop-ups.
 - 3. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
 - 4. Complete and detailed bills of materials identified by each cabinet. Include with each bill of material item the following:
 - a. Quantity.
 - b. Description.
 - c. Manufacturer.
 - d. Part numbers.
- D. Operation and maintenance manuals:
 - 1. Complete installation, operations, calibration, and testing manuals as described in Section 17050.
- E. Record documents:
 - 1. Electrical connection diagrams revised to reflect any changes made in the field and submitted as record Drawings.

1.06 QUALITY ASSURANCE

- A. As specified in Section 17050.
- B. Examine the complete set of Contract Documents and verify that the LOI equipment is compatible with the installed conditions.
- C. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.
- D. Provide LOI hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- E. System compatibility:
 - 1. The software must be the standard operating software system designed specifically for use with the LOI hardware.
 - 2. The software must be furnished and developed by the manufacturer of the LOI hardware.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 17050.

1.08 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 17050.
 - 1. Provide LOI equipment suitable for the installed site conditions including, but not limited to, site altitude, site seismic conditions, humidity, and ambient temperatures.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

- A. As specified in Section 17050.
- B. Provide system upgrades and maintenance fixes for a period of 2 years from substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Allen-Bradley: PanelView Plus 7 Standard.
 - 2.
- B. Provide the LOI graphic software system manufactured by the LOI hardware manufacturer.
- C. One of the following or equal:
 - 1. Rockwell Software FactoryTalk View Machine Edition.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Local Operator Interface:
 - 1. General:
 - a. Provide local operator interfaces located on the face of the VCP as indicated in the contract documents.
 - b. NEMA 12 rated.
 - c. Local Operator Interface consists of graphical display screen with operator input capabilities.
 - d. Capable of stand-alone operation in conjunction with 1 PLC.
 - e. Equipped with data network communication capabilities.
 - 2. Display:
 - a. Type:
 - 1) Color TFT LCD screen.
 - b. Resolution:
 - 1) 640 by 480 pixels.
 - c. Size: As 10.4".
 - d. Easy display viewing at any angle in various ambient light conditions.
 - e. Operator input:
 - 1) Configurable touch screen.
 - f. [Screen update speed: The screen update speed and screen change speed less than 1 second.
 - g. Provide following features for outdoor use:
 - 1) Anti-glare screen overlay.
 - 2) Luminescence: Minimum 1,000 Nits.
 - 3. Graphic configuration:
 - a. Easily configured graphics by:
 - 1) Portable laptop computer both locally and via the PLC data network.
 - b. As specified in Section in this Section.
 - 4. Memory:
 - a. Application:
 - 1) 32 MB Flash EPROM.
 - 2)
 - 5. CPU: Minimum 100 MHz.
 - 6. Communications:
 - a. Ethernet/IP.
 - 7. Environment:
 - a. Temperature: 0 to 50 degrees Celsius.
 - b. Relative humidity: 10 to 90 percent.
 - 8. Electrical:
 - a. Power supply:
 - 1) 120 VAC.
- B. Human machine interface software:
 - 1. Provide a complete software package to be used for programming the necessary screens and operator interaction with the LOIs.
 - 2. Operating system:
 - a. Microsoft Windows 7.
 - 3. Furnish software with preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.
 - 4. Software must allow bitmaps to be imported or exported to or from other applications.

5. Capable of generating custom reports, complete with screen prints.
6. Capable of working with multiple screens concurrently.
7. Provide dialog boxes for defining object attributes.
8. Configure objects using fill in dialog boxes.
9. Furnish graphic and text editor that allows custom formatting in order to customize and change the appearance of objects and text:
 - a. Allow selection of different fill patterns to define object status.
10. As a minimum, provide the following object capabilities:
 - a. Operator inputs:
 - 1) Momentary pushbutton.
 - 2) Maintained pushbutton.
 - 3) Latched pushbutton.
 - 4) Multistate pushbutton.
 - 5) Keypad enable button.
 - 6) Cursor point.
 - b. Control list selectors:
 - 1) Standard control list.
 - 2) Piloted control list.
 - c. Global objects.
 - d. Display objects:
 - 1) Bar graph.
 - 2) Scale.
 - 3) Message display.
 - 4) Multistate indicator.
 - 5) List indicator.
 - 6) Numeric data display.
 - e. Screen selector objects:
 - 1) Go to.
 - 2) Return.
 - 3) Screen list selector.
 - f. Embedded variables:
 - 1) Time.
 - 2) Date.
 - 3) Numeric variable.
 - g. Graphics:
 - 1) Lines.
 - 2) Shapes.
 - 3) Freeform drawings.
 - 4) Imported graphics.
 - 5) Background text.
 - 6) Selection table for standard ISA symbols.
 - 7) PID controller faceplate.
 - h. Alarm screens.
11. Documentation:
 - a. Provide complete user documentation, including examples of how to operate the various modules within the system.
 - b. Provide the documentation in electronic format, HTML based with the ability to search for topics by keyword or search or specific text.

12. On-line help:
 - a. Provide an on-line "help" facility, based upon Windows standard Hypertext:
 - 1) Useful, context-sensitive information on the operation of the package:
 - a) That can be invoked on-line through a point-and-click operation.
 - b) The "help" facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. As specified in Section 17050.

PART 3 EXECUTION

3.01 EXAMINATION

- A. As specified in Section 17050.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 17050.
- B. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- C. Provide panel support bracing if more than 25 percent of the area has been removed to allow for the mounting of the LOI.
- D. All tags used and/or assigned as part of the application programming work are to use the tag and loop identifications found on the P&IDs.
- E. Station graphics:
 1. Configure the graphic display for each device both in the treatment plant, and/or process area, including but not limited to:
 - a. Symbols for:
 - 1) Pumps.

- 2) Valves.
- 3) Major instruments.
- 4) Flowmeters.
- 5) Pressure transmitter.
- 6) Major equipment.
- b. Alarm symbols including intrusion alarm.
- c. Relevant test and operational data.
- d. Status for each controller or controlled device:
 - 1) Hand-Off-Auto Status.
 - 2) Local-Off-Remote Status.
 - 3) Run.
 - 4) Call.
 - 5) Fail.
 - 6) Open.
 - 7) Close.
 - 8) Hold.
 - 9) Modulate.
 - 10) Running.
- e. Depict a change of state of pumps and valves by a change in color.
- 2. Production and usage bar graph:
 - a. Depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.
- 3. System level summary:
 - a. Show the level for the plant influent and effluent production, etc, via a display using bar graphs and numbers, as determined during the requisite graphics meeting.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 17050.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

- A. As specified in Section 17050.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 17050.
- B. Perform the training using pre-approved and qualified representatives of the ICSC and or manufacturer of the LOI software:

1. A representative of the ICSC may perform the training only if the representative has completed the manufacturer's training course for the LOI software.

3.11 PROTECTION

- A. As specified in Section 17050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17733

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Materials and equipment used in process control and LAN networks including:
 - a. Network switches.
 - b. Media converters.
 - c. Routers.
 - d. Patch panels and other data network hardware.
 - e. Related accessories.
- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 01330 - Submittal Procedures.
 - b. Section 16075 - Identification for Electrical Systems.
 - c. Section 16125 - Fiber Optic Cable and Appurtenances.
 - d. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
 - e. Section 17730 - Control Systems: PCS Computer Equipment.
 - f. Section 17950 - Testing, Calibration, and Commissioning.

1.02 REFERENCES

- A. As specified in Section 17050.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 802.3 - Ethernet.
 - 2. 802.11 - Wireless LANs.

1.03 DEFINITIONS

- A. As specified in Section 17050.

1.04 SYSTEM DESCRIPTION

- A. Provide all network equipment identified in the Contract Documents.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 and 17050.
- B. Product data:
 - 1. Include information on all network equipment.
 - 2. Manufacturer's operation and installation instructions.
- C. Shop drawings:
 - 1. Complete set of drawings including but not limited to:
 - a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information, and address settings.
 - b. Network riser diagram.
 - c. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
 - d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
 - e. Electrical connection diagrams.
 - f. Complete grounding requirements.
 - 2. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
 - 3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
 - a. Quantity.
 - b. Description.
 - c. Manufacturer.
 - d. Part numbers.
- D. Test reports:
 - 1. As specified in Sections 16125, 17950, and noted in this Section.
 - 2. Signed test results as described in this Section.
 - 3. Test results shall include:
 - a. Narrative describing the test procedures followed.
 - b. Block diagram of test set up.
 - c. Manufacturer's information on test equipment used.
 - d. Detailed test results.
 - e. A narrative summarizing the results of the testing and identifying any further action required.
- E. Operating manuals:
 - 1. Complete installation, operation, calibration, and testing manuals as specified in Section 17050.
- F. Record drawings:
 - 1. As specified in Section 17050.
 - 2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.06 QUALITY ASSURANCE

A. As specified in Section 17050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Ethernet switches:

1. Managed Enterprise Ethernet switches:

a. Manufacturers: One of the following no equal:

a) N-Tron NT24K-AC1.

b. Properties:

1) Hardware:

a) 19-inch rack mountable modular switch.

b) Power supply:

(1) Provide redundant power supplies.

(2) 120 VAC, 60 Hertz, 1 phase 1,300 Watts.

c) Console management port.

d) Open module slots for the addition of modules as described below.

- 2) Performance:
 - a) Latency: less than 5 microsecond.
 - b) Switch fabric speed: 33.6 Gbps, minimum.
 - c) Address Table Size: 8,000 entries, minimum.
 - d) Gigabit throughput.
- 3) Environment:
 - a) Operating temperature range: 32 to 104 degrees Fahrenheit.
 - b) Humidity: 15 to 95 percent, non-condensing.
- 4) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
 - a) Port Monitoring.
 - b) Remote switch management.
 - c) Port Security.
 - d) Switch meshing.
 - e) Rapid Spanning Tree protocol.
- 5) Capable of adding or swapping modules without interrupting the network.
- 6) Connector type:
 - a) Fiber: SC
 - b) Copper: RJ-45.
- 7) Modules:
 - a) 10/100-Base-TX:
 - (1) Protocol: IEEE 802.3 Type 10Base-T; 802.3u Type 100Base-TX.
 - (2) Auto-sensing.
 - (3) 24 ports per module.
 - b) Fiber optic 100-Base-FX:
 - (1) Protocol: IEEE 802.3u Type 100Base-FX.
 - (2) Full Duplex.
 - (3) 12 ports per module.
 - (4) Multimode
 - c) 100/1000-Base-T:
 - (1) Protocol: IEEE 802.3u Type 100Base-TX; 802.3ab Type 1000Base-T.
 - (2) Auto-sensing.
 - (3) 20 port per module.
 - d) Mini GBIC:
 - (1) Protocol: Based on GBIC module.
 - (2) Full duplex.
 - (3) 4 ports per module.
 - e) Provide modules required to provide network connections as indicated on the Drawings:
 - (1) As required to provide the number of connections required plus 20 percent spare ports of each type used.
 - f) GBIC or Transceiver module:
 - (1) Provide transceiver module to interface with single port transceivers as required.
 - (2) Transceiver modules capable of connecting 3 single port transceivers.

- 8) Spare parts:
 - a) Provide the following spare components:
 - (1) One spare module of each type provided.
 - (2) One spare Ethernet switch backplane.
- B. Patch panels:
1. General:
 - a. Fiber:
 - 1) All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
 - 2) All fibers, active and dark, shall be terminated at the patch panels.
 - 3) Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
 - 4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
 - b. Copper:
 - 1) Final connections between the patch panel and network equipment shall be by patch cords.
 - 2) All premises cables shall be terminated at the patch panels.
 - 3) Cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out conductors.
 - 4) Maintain twist of broken out conductors per EIA/TIA standards.
 2. Rack mounted fiber and copper patch panels:
 - a. Manufacturers: One of the following or equal:
 - 1) Hubbell.
 - 2) Siemon HD.
 - 3) Panduit.
 - b. Copper patch panels and connectors shall meet the following (minimum) requirements:
 - 1) Category 6.
 - 2) RJ-45 patch cord termination:
 - a) Punch Down Block.
 - 3) Mounting: 19-inch rack mount.
 - 4) Accessories:
 - a) Rear cable management bracket.
 - b) Rear individual port labels.
 - c) Front color coded individual port labels.
 - c. Provide copper and fiber patch cables as required to support all network devices.
 - d. Provide 4 spare straight through patch cables.
 - e. Provide 1 spare cross over cable.
 3. Cabinet style fiber patch panels:
 - a. Wall mounted interconnect:
 - 1) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
 - 2) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.

- 3) Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
- 4) Capacity:
 - a) As shown on the plans, minimum 6 connections.
- 5) Accessories:
 - a) Door lock.
 - b) Blanks for unused connector panels.
- 6) Manufacturers: The following or equal:
 - a) Corning Cable Systems, Wall-Mountable Interconnect Center.
- b. DIN rail mounted:
 - 1) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
 - 2) DIN rail mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
 - 3) DIN rail mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
 - 4) Capacity:
 - a) As shown on the plans, minimum 6 connections.
 - 5) Accessories:
 - a) Blanks for unused connector panels.
 - 6) Manufacturers: The following or equal:
 - a) Hirshmann MIPP.
 - b) DINSpace SNAP XL.

C. Server racks:

1. Manufacturers: The following or equal:
 - a. Hoffman Proline.
2. Properties:
 - a. Glass front door (lockable).
 - b. Perforated rear door (lockable).
 - c. Perforated top with 2 cable entries.
 - d. Fully welded frame.
 - e. 20 Amp surge protected power strip.
3. Velcro cable wraps.
 - a. Furnish casters as indicated on the Drawings.

D. Communications Cabinets:

1. Manufacturers: One of the following or equal:
 - a. Hoffman Proline CL.
 - b. Rittal TS8.
 - c. Panduit.
2. Properties:
 - a. Co-location:
 - 1) 3 doors.
 - a) Provide two compartments:
 - (1) Top third of cabinet reserved for future enterprise networking equipment.
 - (2) Bottom two thirds of cabinet shall be used for the process control network.
 - 2) 42 rack units total.
 - b. Locking front door.

- c. Louvered rear door.
- d. Power strip.
- e. Corded fan kit.
- f. Furnish shelves as needed.
- g. Furnish writing surface.
- h. Furnish cable keeper/organizer.
- i. Furnish casters as indicated on the Drawings.
- j. Rating:
 - 1) Electrical areas: NEMA 12.

E. Optical Communication:

- 1. Manufacturers: The following and no equal:
 - a. Phoenix Digital OCX-ETF-85-P-D-SC-ACV
- 2. Properties:
 - a. Hardware:
 - 1) Power Supply: 120VAC, 60Hz
 - 2) OCX-EFT optical communication module for 10/100 Mbps Ethernet Networks.
 - 3) Rating: NEMA 12 module enclosure.
 - b. Connector Type:
 - 1) Copper: RJ-45.
 - a) Ports: 6.
 - 2) Fiber: SC
 - a) Ports: 4.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.
- B. Furnish accessories as specified in Section 17730.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 17050.
- B. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system as indicated on the Drawings and as specified herein:
 - 1. Refer to SCADA block diagrams for all new network connections.
 - 2. Provide configuration for all managed Ethernet switches and other components including but not limited to VLAN (virtual local area network), additional Plant PLC communication cards and separate managed Ethernet switches as required, such that there is isolation of the following networks:
 - a. Field and PLC I/O network: This includes the connections between the Plant PLC and:
 - 1) Plant PLC expansion racks.
 - 2) Plant PLC remote I/O (RIO) racks.
 - 3) Field Networks.
 - 4) LOI(s) part of a Plant PLC.
 - 5) Vendor furnished Ethernet network components.
 - b. Process Control network: This includes the connections between the Plant PLC and other Plant PLCs.
 - c. SCADA network: This includes the connections between the various SCADA equipment including but not limited to servers (existing), workstations and printers.
 - d. Security network: This includes any security hardware with Ethernet communication as provided by the security/telephone/internet sub-contractor,
 - 3. The enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.
- C. All racks shall be level and plumb.
- D. Install Velcro wrap on all cable bundles within the network rack/enclosure.
- E. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
 - 1. Cables shall be installed avoiding sharp bends.
 - 2. Install cable using lubricant designed for cable pulling.
 - 3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
 - 4. Install LAN cables without splices.
 - 5. Installed bend radii shall not exceed 4 times the cable diameter.
 - 6. Terminated all pairs at the jack and the patch panel.
- F. Install cables a minimum of 40 inches away from electrical motors and transformers.
- G. Install cables a minimum of 12 inches away from fluorescent lighting.
- H. Individual pairs will be untwisted less than 1/2 inch at termination points.

- I. All cables and terminations shall be labeled with cable designations as specified in Section 16075.
- J. Each data port shall be individually labeled with its patch panel/switch port ID:
 - 1. Labeling must be printed - no handwritten labels will be allowed.
- K. At the completion of the wiring installation, provide the following documentation:
 - 1. A plan-view of the premise(s) showing the jack numbering scheme.
 - 2. A printed certification report for the entire wiring installation showing compliance with all EIA/TIA specifications for data cable.
 - 3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.
 - 4. Each device with a unique IP address shall be individually labeled with its IP address. The labeling must be printed; handwritten labels will not be allowed.
- L. Managed Ethernet switches:
 - 1. Configure switches to prevent broadcast storms.
 - 2. Installations utilizing Rockwell PLCs and multicast messaging shall employ IGMP and snooping on all Rockwell components.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING

- A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.09 CLEANING

- A. As specified in Section 17050.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 17050.
- B. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.
- C. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17762

CONTROL SYSTEMS: PCS SOFTWARE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. PCS system software to be used for application software development and real time operation of the PCS system.

- B. Related sections:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
 - 3. Section 17100 - Control Strategies.
 - 4. Section 17720 - Control Systems: Programmable Logic Controllers.
 - 5. Section 17950 - Testing, Calibration, and Commissioning.

- C. General requirements:
 - 1. Software provided under this Contract represents a complete and operating control software system. Achieve the functionality specified in this and other sections through a combination of standard control system software and application software developed specifically for this Project.
 - 2. The standard control software listed in this Section does not represent a comprehensive list of software necessary to implement the functional requirements of the Contract Documents. Provide all necessary supplemental drivers, utility software and application software, as required, to meet the functional requirements of the Contract Documents.
 - 3. Applications software requirements are described in Section 17100.
 - 4. License all software for proper operation as described in the Contract Documents.
 - 5. License all software provided under this Contract to the Owner.

- D. Provide copies of all software on CD, or equivalent media.

1.02 REFERENCES

- A. As specified in Section 17050.

1.03 DEFINITIONS

- A. As specified in Section 17050.

1.04 SYSTEM DESCRIPTION

- A. PCS system node descriptors:
1. PCS client workstation: Client workstations shall be provided with all graphic display and related software for interacting with the PCS system data. PCS client's displays shall operate on data maintained by the PCS server. Display capabilities shall include, but not be limited to:
 - a. Process mimic displays.
 - b. Real time and historical trend displays.
 - c. Alarm summary and sub-summary displays.
 - d. System utilities.
 2. PCS terminal server: Provide the PCS terminal server with the required software and licenses to deploy instances of PCS client workstation to PCS terminal services clients.
 3. PCS terminal services client: Provide the PCS system terminal services client with the required software and licenses required to access and display all graphic displays deployed from the PCS terminal server.
 4. PCS development node: Provide the PCS system development node with software and licenses required to edit the programs and configuration files as part of the system application development. Unless otherwise indicated, the development node shall be complete with run time software for fully testing the application programs. Functions required at the development node include:
 - a. Edit the PCS database.
 - b. Edit graphic displays.
 - c. Modify alarm files.
 - d. Modify PLC programs.
 - e. Modify programs and scripts executing at any of the workstations.
 - f. Set up trends and historical displays.
 - g. Edit user authorizations.
 - h. Other functions as may be required to modify the PCS system application software.
 5. PCS I/O server: Provide server nodes with software and licenses as needed to communicate with the PLCs and other data providers and maintain a real time database of system values. Unless otherwise indicated, server nodes shall be equipped with client software for the viewing of the real time data. The PCS server will include input/output drivers for interfacing with field devices, and buffer historical data, and provide data for the historian node(s). On systems not containing a historian node, the PCS servers will maintain permanent data files containing the historical data. Provide redundant PCS servers complete with software required for synchronization and auto-fail over. PCS server will include separate network interface cards (NIC) for the PCS to PLC network, PCS to PCS network, and PCS server network when redundant fail over PCS servers are provided.
 6. PCS Application Server node: The Application server is a development node with software and licenses as needed to edit and deploy the PCS application to all PCS nodes. In the event the application server is unavailable when another node requests the application, a local cached copy of the application runs on the client node.

7. Historian server: The historian server collects real time data and compresses the values into historical records for trending and reporting. Unless otherwise indicated, the historian server shall archive data provided by the PCS server. The server shall be provided with software for interfacing with standard report software packages via MS-SQL, ODBC and other standard interfaces as described in this Section. Provide software required for collector redundancy when auto-fail over PCS servers are supplied.
8. Alarm node: Each client workstation is equipped with an alarm window on the operator display with local annunciation. Where a separate alarm node has been indicated, this node shall handle the interface to telephone, paging and radio alarming systems.

B. General:

1. Contractor shall provide PCS software, as required for a complete and functional PCS system as indicated on the Drawings and as specified in this Section:
 - a. Provide software on the system nodes as follows:
 - 1) 2 – PCS servers with Auto Fail-Over.
 - a) Primary server in Control Room 19” rack.
 - b) Secondary server in Control Room 19” rack.
 - 2) 1 – 1000 point minimum historian with collector redundancy.
 - a) Historian server in Control Room 19” rack.
 - 3) 2 – PCS client workstations.
 - a) Operator workstation in Control Room.
 - b) Engineering workstation in Control Room.
 - 4) 1 – PCS terminal server w/ three PCS terminal services client licenses.
 - a) Terminal server in Control Room 19” rack.
 - 5) 2 – PCS terminal services clients.
 - a) Process control operations laptop.
 - b) Plant Supervisor's Office workstation.
 - b. System configuration:
 - 1) The system consists of a primary and backup data servers configured for hot failover operation. Server nodes shall be equipped with I/O drivers from communicating with networked PLCs.
 - 2) Client machines obtain real time data from the I/O servers. The client machines shall monitor the status of the servers and re-establish data connections with a new server in case the primary server fails.

C. Security:

1. User Groups:
 - a. The system will use User Groups to assign screen access and control action permissions within the system dependent on the login credentials of the user.
 - b. A user group with minimal permissions will always be logged in if no other user group is logged in. This user group will be limited to view only and basic screen navigation.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 and 17050.

- B. Remote alarm database:
 - 1. After development of the PCS system database but before system start-up, provide a list of points configured for alarming and submit to the Owner and the Engineer. The Owner/Engineer will identify critical alarms for use in the extended alarming system (e.g. dialer system, paging) and provide response descriptions.
- C. Alarm descriptions shall be of sufficient detail for an accurate review by the Owner.
- D. After all shop drawings submittals required herein have been favorably reviewed by the Engineer, the ICSC shall submit the following items, which must also be favorably reviewed and implemented prior to the start of system testing, the entire control system including all required software packages must be operational prior to the required factory acceptance test:
 - 1. All operator interface display submittals shall be in full color as they will appear on the display screen:
 - a. This submittal shall be prepared after the requisite graphics meetings.
 - b. The submittal shall include:
 - 1) Graphic displays.
 - 2) Trend displays.
 - 3) Alpha numeric displays.
 - 4) Alarm displays.
 - 2. Each display shall be uniquely titled:
 - a. Locations for process data shall be clearly identified either through the use of simulated data or by showing variables on the displays and providing a reference list describing those variables.
 - b. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets:
 - 1) Color change.
 - 2) Symbol change.
 - c. Three sets of submittals, with screen prints in color on a white background, are required for review by the Owner and Engineer.
 - d. One set will be returned with comments.
 - 3. All periodic and custom reports for the entire control system:
 - a. Locations for process data shall be clearly identified, either through the use of simulated data or by showing variables on the report and providing a reference list describing those variables.
 - b. Three sets of reports shall be submitted for review by the Engineer.
 - c. One set will be returned with comments.
- E. Pre-acceptance test documentation as specified in the Sequencing article of this Section.
- F. Operator's reference manual:
 - 1. The ICSC shall prepare and submit a user reference manual for the operator interface system for use by the operators. This manual shall be bound in a 3-ring binder and meet the following minimum requirements:
 - a. An index to the manual.
 - b. A list of operator interface:
 - 1) Display screens.
 - 2) Trends.
 - 3) Reports.

- 4) With display name and description.
- c. A summary of all possible commands and operator inputs to these screens including setpoints:
 - 1) All control actions shall be included.
- d. A control system block diagram with names and locations of major components.
- e. Instructions for manually printing screens or reports.
 - 1) Real time.
 - 2) Historical.
- f. A summary of security levels and their privileges and limitations.
- g. Spaces for operators to make notes.
- 2. A copy of this manual shall be provided to each operator during training on the operator interface operations:
 - a. The training class shall include a review of this manual with the operators in addition to more detailed instruction on the operator interface configuration and its use.

- G. Review meeting minutes submittals:
 - 1. Graphics review meeting:
 - a. Minutes of Graphic Review Meeting No. 1.
 - b. Minutes of Graphic Review Meeting No. 2.
 - 2. Report review meeting:
 - a. Minutes of Report Review Meeting No. 1.
 - b. Minutes of Report Review Meeting No. 2.
 - 3. Alarm review meeting:
 - a. Minutes of Alarm Review Meeting No. 1.
 - b. Minutes of Alarm Review Meeting No. 2.

1.06 QUALITY ASSURANCE

- A. As specified in Section 17050.
- B. The manufacturer must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software:
 - 1. The presence of a formal quality assurance department is required.
- C. Software provided under this Section shall be included in the testing specified in Section 17950.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

- A. The following items shall be submitted with the final sets of technical manuals required as specified in the Submittals article of this Section, 15 working days before the pre-commissioning test as specified in Section 17050:
 - 1. All program manuals supplied by the manufacturers with the standard software packages.

2. All original program disks supplied by the manufacturers with the standard software packages, including any program revisions or updates issued by the manufacturers during the construction period.
 3. All PLC program and operator interface application program files stored on labeled disks:
 - a. The PLC program and operator interface application program file disks shall also be updated as required if any changes or corrections are required in this programming before Project completion.
- B. Operator interface graphics generation:
1. The ICSC through the Contractor shall schedule the operator interface graphics meetings.
 2. Topics shall include graphics for:
 - a. HMI graphics.
 - b. Data acquisition and graphics display system.
 3. The Owner and Engineer shall attend these meetings.
 4. Graphics Meeting No. 1: Held in conjunction with the Preliminary Meeting as specified in Section 17050:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance of the meeting, which shall address the basic criteria to be adhered to in the configuration and development of graphic displays:
 - 1) At this meeting, the ICSC shall distribute sample display formats for illustration purposes.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) All in plant and remote site areas and conventions for identifying tag names and descriptors.
 - b) Designation of groups within each plant area along with tag names and descriptors.
 - c) The assignment of individual control loops and inputs to specific groups.
 - d) Organization of the systems universal display hierarchy.
 - e) Paging schemes to be used to enable the movement from one display to another.
 - f) An itemization of the type of display to be used at each level in the graphic hierarchy, i.e., pre-formatted displays, templates, custom graphics, etc.
 - g) Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms based on alarm priority, background colors, static field colors and dynamic field colors.
 - h) The utilization of blinking and conditional text.
 - i) Definition of graphic symbolism to be used on the Project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves:
 - (1) All symbolism must be specific as opposed to generic in that shapes must define both function and type, i.e., specific symbols for each valve design, each pump design, each type of flowmeter, etc.
 - (2) If the ICSC's library of shapes does not adequately describe plant or field conditions, the ICSC shall develop additional shapes to meet the plant or field requirements.

- (3) Shapes and symbols used on the P&IDs shall be used as a guideline.
 - j) Definition of all display select commands that enable the operator to move within the display hierarchy.
 - k) The utilization of cursor movement commands which enable the operator to move within a display.
 - l) Definition of control input commands which enable the operator to interact with face plates control stations and custom graphic displays to implement control functions.
 - m) Definition of data input commands which enable the operator to enter numeric values into the control system.
 - n) Definition of the utilization of "poke" points or fields that are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.
 - o) A review of graphic generation procedures.
 - b. Subsequent to the adjournment of Graphics Meeting No. 1, the ICSC shall prepare and formalize a document titled "Graphics Criteria" which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to:
 - 1) This report shall be supplemented by graphic examples which illustrate the incorporation and application of each graphic criteria.
 - 2) The report shall be submitted within 30 calendar days of the meeting's adjournment.
 - 5. Graphics Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 17050:
 - a. Subsequent to the finalization of the overall system-wide graphics criteria, the ICSC shall develop graphic packages for the entire operator interfaces being furnished under this Project.
 - b. At this meeting the ICSC shall submit 5 copies including:
 - 1) A review of the graphic package developed for the process areas for content and completeness.
 - 2) A review of all data fields that display automatically updated process information.
 - 3) A review of all required input commands associated with the graphic access and control manipulation.
 - c. Subsequent to the adjournment of Graphics Meeting No. 2, the ICSC shall prepare a formalized submittal of the graphic package for review along with the detailed meeting minutes:
 - 1) The report shall be submitted within 30 calendar days of the meeting adjournment.
 - 6. 10 additional displays shall be configured on-line during the pre-commissioning test period.
- C. Report generation:
- 1. The ICSC through the Contractor shall schedule the report generation meetings.
 - 2. The Owner and Engineer shall attend these meetings.

3. Reports Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 17050:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the configuration and development of the reports:
 - 1) At this meeting, the ICSC shall distribute sample formats for illustration purposes.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) All in plant and remote site data and conventions for identifying tag names and descriptors.
 - b) Designation of groups within each plant area along with tag names and descriptors.
 - c) The assignment of inputs to specific categories.
 - d) Organization of the systems universal report categories.
 - e) An itemization of the type of report available.
 - f) Definition of terms to be used on the reports.
 - g) Definition of all report commands that enable the operator to move within the report editor.
 - h) The utilization of cursor movement commands which enable the operator to move within a report.
 - i) Definition of data input commands which enable the operator to enter numeric values into the system.
 - j) A review of report generation procedures.
 - 3) Subsequent to the adjournment of the Report Meeting No. 1, the ICSC shall prepare and formalize a document titled "Report Criteria" which shall contain detailed meeting minutes and a definition of all report guidelines to be adhered to:
 - a) This report shall be supplemented by report examples.
 - b) The report shall be submitted within 30 calendar days of the meeting's adjournment.
4. Reports Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 17050:
 - a. Subsequent to the finalization of the overall report format criteria, the ICSC shall develop report packages for review.
 - b. At this meeting the ICSC shall submit 5 copies including:
 - 1) A review of the report package developed for the process area(s) for content and completeness.
 - 2) A review of all data fields for process information.
 - 3) A review of all required input commands associated with the report access and control manipulation.
 - c. Subsequent to the adjournment of Report Meeting No. 2, the ICSC shall prepare a formalized submittal of the report package for review along with the detailed meeting minutes:
 - 1) The report shall be submitted within 30 calendar days of the meetings adjournment.
5. 10 additional reports shall be configured on-line during the pre-commissioning test period.

D. Alarming priority:

1. The ICSC through the Contractor shall schedule the alarming priority meetings.
2. The Owner and Engineer shall attend these meetings.

3. Alarming Priority Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 17050:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the prioritization of alarms:
 - 1) At this meeting, the ICSC shall distribute a listing of all plant alarms identified by tag names and descriptors.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) Criteria for prioritizing alarms including alarming priority levels. (i.e. Priority 3 - alarm at PCS; Priority 2 – alarm at PCS and autodialer; Priority 1 – alarm at PCS, autodialer, and plant shutdown.)
 - b) Alarm display banner basic criteria.
 - 3) Subsequent to the adjournment of the Alarming Priority Meeting No. 1, the ICSC shall prepare and formalize a document titled "Alarm Criteria" which shall contain detailed meeting minutes and a definition of all alarming guidelines to be adhered to:
 - a) The report shall be submitted within 30 calendar days of the meeting's adjournment.
4. Alarming Priority Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 17050:
 - a. Subsequent to the finalization of the overall alarm criteria, the ICSC shall develop an alarming priority spreadsheet that will be populated at this meeting.
 - b. At this meeting the ICSC shall provide a spreadsheet including:
 - 1) A listing of all plant alarms identified by tag names and descriptors.
 - 2) For each alarm listed include a location to enter the alarm priority assignment.
 - 3) For each alarm listed include a location to enter specific comments related to that alarm.
 - c. Subsequent to the adjournment of Alarming Priority Meeting No. 2, the ICSC shall prepare a formalized submittal of the alarming priority spreadsheet for review along with the detailed meeting minutes:
 - 1) The spreadsheet and meeting minutes shall be submitted within 30 calendar days of the meetings adjournment.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

- A. Provide 3-year extended manufacturer's warranty as follows:
 1. Dedicated technical support department or handled by programming staff or distributor.

2. Telephone support available 24 hours per day.
 3. Email and web support addresses.
 4. FTP download area.
 5. Knowledge base.
 6. Bulletin board service.
 7. Field service.
- B. Provide system upgrades and maintenance fixes for a period of 2 years from Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
1. Rockwell Automation Factory Talk View Site Edition.
- B. The software revision of the package used should be of the latest version which has been released for a minimum of 1 year.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. General:
1. Unless otherwise indicated, provide all run time and development software licensed for:
 - a. Unlimited screens.
 - b. No direct limits on the number of connections to a server machine.
 - c. Provide the number of client licenses as indicated by the number of machines shown or specified, the addition of a new client shall not require an upgrade to the server license.
 - d. Historian tags: Provide at least 50 percent of the number of I/O SCADA tags.
 2. Provide software and licenses as required to implement the system architecture and functionality as indicated on the Drawings and as described in the System Description article of this Section.
 3. License/registered all software in the Owner's name.
 4. Turn all software installed on the workstation, over to the Owner with disks, keys and manuals.
 5. The system software specified as part of this Section support PCS system functions including, but not limited to:
 - a. Human machine interface (HMI) process graphics development and display.
 - b. Real time point database development and display.
 - c. Historical database generation, collection, and display.
 - d. Alarming subsystem.
 - e. Trending and report subsystems.
 - f. Drivers and interfaces.
 6. PLC programming software is specified in Section 17720.

- B. Operating system software:
 - 1. Provide all workstations and servers with operating system software compatible with the software provided under this Section:
 - a. Client nodes: Microsoft Windows 7 Professional, 64-Bit.
 - b. Server nodes: Windows 2012 Server is the preferred operating system, if legacy 32-bit software is to be run on the server, Windows 2008 Server (32-bit) is acceptable. Include 2 Client Access Licenses (CALs).
 - 2. Provide all operating system software as a clean install. Where workstations have been loaded with OEM versions of software containing trial software or other advertisements, remove the OEM software and reinstall the operating system and all drivers from the original installation disks.
 - 3. Provide all workstations with recovery disks.
- C. Virtualized Operating Systems:
 - 1. When a virtual environment is used for the operating system, it is the responsibility to the ICSC to verify compatibility of the PCS software package with the Virtual Operating System software.
 - 2. Provide host machine hardware to meet the minimum requirements of the Virtualized Operating System(s).
 - a. If multiple virtual environments are used on the same host or in a cluster, a hypervisor should be used to manage resource pool and memory allocation such that each virtual operating system has the recommended minimum hardware resources.
 - 3. Synchronize all virtual timekeeping with a single real external time source.
- D. PCS HMI run time software:
 - 1. Provide run time software and licenses for all control system workstations provided.
 - 2. Include client licenses for I/O server machines.
 - 3. License all software in the Owner's name.
- E. PCS I/O server software:
 - 1. Provide software and licenses for a full PCS system node including I/O drivers.
 - 2. Provide drivers for all control system devices as indicated on the Drawings.
 - 3. Configure historical data collectors to provide data for the historical database on all I/O servers.
 - 4. License all software in the Owner's name.
- F. PCS Application Server:
 - 1. Provide run time software and licenses for full PCS system node.
 - 2. License all software in the Owner's name.
- G. Development workstations:
 - 1. For development workstations provide all software for the generation and modification of the graphic screens, PCS system databases, access control files and supervisory control programs.
 - 2. The development node contains all client software and licenses for use as an additional operator display.
 - 3. The development node shall be equipped with I/O drivers for live testing of screens and control programs.
 - 4. License all software in the Owner's name.

- H. Historian server:
 - 1. Provide the latest version of the historian software.
 - 2. Use data collectors to buffer historical data in the event of a loss of communication with the history server.
 - 3. Provide Microsoft SQL client access licenses for all nodes in the system plus an allowance for 50 percent expansion.

- I. Licensing:
 - 1. Provide hardware keys will utilize the USB form factor.

- J. Alarm dialer software:
 - 1. Install the alarm dialer software on the workstation identified as the alarm node.
 - 2. The alarm software shall interface with the PCS system via the PCS system client software and provide an interface to the appropriate external alarming system.
 - 3. Provide 1 copy of the alarm dialing software:
 - a. Win911 Event Notification Software by Specter Instruments.
 - b. Or equal.

- K. Miscellaneous software:
 - 1. Provide the following support software for use on the PCS system computers. Install all software on the appropriate system node. Provide all software CD/DVD media. License all software to the Owner:
 - a. Provide Symantac's Norton Ghost software for the backup of all system nodes DVD.
 - b. Provide 2 copies Microsoft Office 2010 for generating and editing of reports.
 - 1) Install one copy on Engineers Workstation and the other copy on the Operator Workstation.
 - c. Provide 1 copy of Sytech xl Reporter Suite for the development of report templates and the event scheduling of automatically generated reports.
 - 1) Install on Engineers Workstation.
 - d. Provide all nodes with virus protection software.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 17050.
- B. Install all required software improvement modules (SIMs). At the completion of the Project, and provide installation disk(s) containing all SIMs used on the Project to the Owner.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. Test all software provided as part of this Section as part of the system tests specified in Section 17950.
- B. Contractor shall cover the costs of tuition, training materials, and related fees.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 17050.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION